NASA LONG RANGE TECHNOLOGY GOALS

VOLUME II-C

TASK 2 REPORT

CONTRACT NASW - 3864

II. U.S. Industrial Sector Tech. Goals

III. Social, Health, & Security Tech. Goals

IV. Functional Space Mission Technologies

V. Recommended Long Range TEch. Goals

This Volume contains the third part of the findings pertaining to the status of the U.S. industrial sector.

(NASA-CR-186481) NASA LONG RANGE TECHNOLOGY GOALS. VOLUME 2-C: TASK 2 REPORT (Ecosystems International) 233 p

N90-70896

Unclas
00/81 0272290

NASA Long Range Technology Goals

Volume II-C

Task 2 Report

CONTRACT NASW-3864

December 1984

PREPARED FOR:

The National Aeronautics and Space Administration

Office of Technology Utilization and Industry Affairs

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FOREWORD

This document is part of the Final Report performed under contract NASW-3864, titled "NASA Long Range Technology Goals."

The objectives of the effort were:

- To identify technologies whose development falls within NASA's capability and purview, and which have high potential for leapfrog advances in the national industrial posture in the 2005-2010 era.

- To define which of these technologies can also enable quantum jumps in the national space program.

- To assess mechanisms of interaction between NASA and industry constituencies for realizing the leapfrog technologies.

This Volume contains the third part of the findings pertaining to the status of the U.S. industrial sector.

OUTLINE OF VOLUMES

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

FOLLOWING IS A LIST OF THE ABBREVIATED GOVERNMENT AGENCIES CITED IN THIS VOLUME.

SOURCES:

U.S. DOC/BIE: U.S. Department of Commerce, Bureau of Industrial

U.S. DOL/BLS: U.S. Department of Labor, Bureau of Labor Statistics

U.S. DOC/BOC: U.S. Department of Commerce, Bureau of the Census

EOP/OMB: Executive Office of the President, Office of Management and Budget

EPA: Environmental Protection Agency

U.S. DOE/EIA: U.S. Department of Energy, Energy Information Administration

B.14 "WHOLESALE AND RETAIL TRADE" (SICs 50-59)

TABLE OF CONTENTS

SOURCES: U.S. DOC/BOC:

Statistical Abstract of the U.S., 1984

U.S. DOC/BIE:

1984 U.S. Industrial Outlook

Census of Manufactures, 1977

EOP/OMB:

Standard Industrial Classification Manual, 1972

TABLE OF CONTENTS (Continued)

LIST OF TABLES

B.14 "WHOLESALE AND RETAIL TRADE" (SICS 50-59)

Taken together, wholesale (SICs 50 and 51) and retail (SICs 52-59) trade are the largest service subsectors, contributing 22.6% to the total value added of all service subsectors and 15.4% to the total GNP in 1980. Sales for wholesale and retail trade during 1977 were $480 billion and $518 billion (1972 $), respectively. Wholesalers are engaged in selling merchandise to retailers; to industrial, commercial, institutional, farm, or professional business users; to other wholesalers; or acting as agents or brokers in buying or selling merchandise to such persons or companies. Retailers are engaged in selling merchandise for personal or household consumption, and rendering services incidental to the sale of the goods.

Wholesaling is broken up into merchant wholesaling (54% of sales), manufacturers' sales branches and offices selling direct (36%), and by agents, brokers, and commission merchants (10%). Merchant wholesalers will be addressed because they are the largest and fastest growing segment of the wholesaling services. Retailing will be considered as a single entity.

Tables 14-1, 14-2 and 14-3 show the major services of each subdivision of the wholesale and the retail trade service with their share of the subsector's contribution to total sales in 1977 ranked according to SIC code. Tables 14-4 through 14-6 summarize the principal economic measures of these subdivisions. The subdivisions are characterized by:

- A high degree of fragmentation with in excess of 2 million establishments for all groups combined (1977).
- A low labor productivity of $12,050 in 1980 (1972 $) ranking this group as fourth out of five service groups. The productivity growth rate averaged 0.25%/year from 1970 to 1980.

TABLE 14-1

CLASSIFICATION OF MAJOR SERVICES OF THE DURABLE WHOLESALE TRADE GROUP AND CONTRIBUTION TO SALES IN 1977

SIC CODE	SUBDIVISION AND TYPICAL SERVICE	% SALES CONTRIBUTION ALL GOODS	% SALES CONTRIBUTION DURABLE GOODS ONLY
508	**MACHINERY, EQUIPMENT, AND SUPPLIES** WHOLESALING BUSINESS MACHINES, COMPUTERS, DUPLICATING MACHINES, CRANES, EXCAVATING, AGRICULTURAL AND INDUSTRIAL MACHINERY, INDUSTRIAL SUPPLIES, MEDICAL SUPPLIES, AND TRANSPORTATION EQUIPMENT.	12.8	28.8
501	**MOTOR VEHICLES AND AUTOMOBILE PARTS AND SUPPLIES** DISTRIBUTION OF NEW AND USED PASSENGER AUTOMOBILES, TRUCKS, AND OTHER MOTOR VEHICLES AS WELL AS AUTOMOBILE PARTS, SUPPLIES, TOOLS, TIRES, AND TUBES.	8.2	18.5
505	**METALS AND MINERALS, EXCEPT PETROLEUM** MARKETING FERROUS AND NONFERROUS METAL, SEMIFINISHED PRODUCTS, COAL, COKE, COPPER ORE, IRON ORE, OTHER NONPRECIOUS ORES, AND CRUDE NON-METALLIC MINERALS (EXCEPT PETROLEUM).	5.1	11.5
506	**ELECTRICAL GOODS** DISTRIBUTION OF ELECTRICAL GENERATING, DISTRIBUTING, AND WIRING EQUIPMENT AS WELL AS HOUSEHOLD APPLIANCES WHETHER ELECTRICALLY, MANUALLY, OR MECHANICALLY POWERED.	4.5	10.2
503	**LUMBER AND OTHER CONSTRUCTION MATERIALS** DISTRIBUTION OF LUMBER, PLYWOOD, DOOR FRAMES, MILLWORK, BRICK, CEMENT, GRANITE, GRAVEL, LIME, PLASTER, ROOFING MATERIALS, SAND AND TILE.	4.1	9.3
509	**MISCELLANEOUS DURABLE GOODS** WHOLESALE DISTRIBUTION OF SCRAP AND WASTE MATERIAL, JEWELRY, PRECIOUS STONES AND METALS, MUSICAL INSTRUMENTS, AND COIN-OPERATED GAME MACHINES.	3.8	8.6
507	**HARDWARE, PLUMBING, AND HEATING EQUIPMENT** DISTRIBUTION OF HAND TOOLS, BOLTS, SCREWS, BOILERS, FURNACES, RADIATORS, COMPRESSORS, AND REFRIGERATION EQUIPMENT.	3.0	6.7
502	**FURNITURE AND HOME FURNISHINGS** DISTRIBUTION OF HOUSEHOLD FURNITURE, OFFICE FURNITURE, ANTIQUES, GLASSWARE, LAMPS, CURTAINS, LINENS, AND FLOOR COVERINGS.	1.7	3.7
504	**SPORTING, RECREATIONAL, PHOTOGRAPHIC AND HOBBY GOODS, TOYS, AND SUPPLIES** SPORTING GOODS, FIREARMS AND AMMUNITION, MARINE PLEASURE CRAFTS, GAMES, HOBBY GOODS, CAMERAS, AND PHOTOCOPY EQUIPMENT DISTRIBUTION.	1.2	2.7
50	**WHOLESALE TRADE—DURABLE GOODS**	44.4	100.0

SOURCES: EOP/OMB: STANDARD INDUSTRIAL CLASSIFICATION MANUAL, 1972
ARTHUR D. LITTLE, INC.

TABLE 14-2

CLASSIFICATION OF MAJOR SERVICES
OF THE NONDURABLE WHOLESALE TRADE GROUP AND
CONTRIBUTION TO SALES IN 1977

SIC CODE	SUBDIVISION AND TYPICAL SERVICE	% SALES CONTRIBUTION ALL GOODS	% SALES CONTRIBUTION NONDURABLE GOODS ONLY
514	**GROCERIES AND RELATED PRODUCTS**	16.6	29.8
	DISTRIBUTION OF GROCERY LINES, FROZEN FOODS, DAIRY PRODUCTS, POULTRY AND EGGS, CONFECTIONARIES, SEAFOODS, MEAT, FRUITS AND VEGETABLES, AND RELATED PRODUCTS.		
515	**FARM PRODUCT RAW MATERIAL**	11.9	21.4
	MARKETING COTTON, GRAIN, LIVESTOCK, AND SIMILAR FARM PRODUCTS.		
517	**PETROLEUM AND PETROLEUM PRODUCTS**	8.8	15.9
	WHOLESALING PETROLEUM AND ITS BY-PRODUCTS.		
518	**BEER, WINE, AND DISTILLED ALCOHOLIC BEVERAGES**	7.1	12.8
	DISTRIBUTION OF BEER, ALE, WINES, AND LIQUORS.		
519	**MISCELLANEOUS NONDURABLE GOODS**	3.3	6.0
	DISTRIBUTION OF FARM SUPPLIES, TOBACCO, AND PAINTS.		
511	**PAPER AND PAPER PRODUCTS**	2.2	4.0
	DISTRIBUTION OF PAPER, STATIONARY SUPPLIES, PENS, BAGS, PAPER CUPS, NAPKINS, AND PAPER TOWELS.		
513	**APPAREL, PIECE GOODS, AND NOTIONS**	2.7	4.8
	DISTRIBUTION OF WOVEN FABRICS, SEWING AND HAIR ACCESSORIES, MALE AND FEMALE CLOTHING AND FOOTWEAR.		
512	**DRUGS, DRUG PROPRIETARIES AND DRUGGISTS' SUNDRIES**	1.5	2.7
	DISTRIBUTION OF DRUGS, DRUGGISTS' SUNDRIES, AND TOILETRIES.		
516	**CHEMICALS AND ALLIED PRODUCTS**	1.5	2.6
	DISTRIBUTION OF CHEMICALS SUCH AS ACIDS, SALT, RESINS, ETC.		
51	**WHOLESALE TRADE—NONDURABLE GOODS**	55.6	100.0

SOURCES: EOP/OMB: STANDARD INDUSTRIAL CLASSIFICATION MANUAL, 1972
A.D. LITTLE, INC.

TABLE 14-3

CLASSIFICATION OF MAJOR SERVICES
OF THE RETAIL TRADE GROUP AND CONTRIBUTION TO SALES IN 1977

SIC CODE	SUBDIVISION AND TYPICAL SERVICE	% SALES CONTRIBUTION
54	**FOOD STORES** SALE OF FROZEN FOOD, MEAT, POULTRY, SEAFOOD, FRUIT AND VEGETABLES, CANDY AND NUTS, DAIRY PRODUCTS, AND BAKED GOODS.	21.8
55 (EXCEPT 554)	**AUTOMOBILE DEALERS** SALE OF NEW AND USED MOTOR VEHICLES, BOATS, RECREATIONAL AND UTILITY TRAILERS, MOTORCYCLES, AIRCRAFT, SNOWMOBILES, AND AUTO AND HOME SUPPLY STORES.	20.7
53	**GENERAL MERCHANDISE STORES** INCLUDES RETAIL STORES WHICH SELL DRY GOODS, APPAREL, FURNITURE, SMALL WARES, HARDWARE, AND FOOD. STORES INCLUDED KNOWN AS DEPARTMENT, VARIETY, AND GENERAL STORES.	12.5
59 (EXCEPT 591)	**MISCELLANEOUS RETAIL** SALE OF LIQUOR, SPORTING GOODS, BOOKS, TOYS, MAIL ORDER HOUSES, AND VENDING MACHINES.	10.4
58	**EATING AND DRINKING PLACES** INCLUDES AUTOMATS, CAFES, DINERS, CATERERS, RESTAURANTS, BARS, TAVERNS, AND NIGHT CLUBS.	8.7
554	**GASOLINE SERVICE STATIONS** SALE OF GASOLINE AND LUBRICATING OILS, AND MINOR REPAIR WORK.	7.8
52	**BUILDING MATERIALS, HARDWARE, GARDEN SUPPLY, AND MOBILE HOME DEALERS** SALE OF LUMBER, PAINT, GLASS, HARDWARE, NURSERY STOCK, LAWN AND GARDEN SUPPLIES, AND MOBILE HOMES.	5.4
56	**APPAREL AND ACCESSORY STORES** SALE OF NEW CLOTHING, SHOES, HATS, UNDERWEAR, AND RELATED ARTICLES.	4.9
57	**FURNITURE, HOME FURNISHINGS, AND EQUIPMENT STORES** SALE OF FURNITURE, FLOOR COVERING, DRAPERY, CURTAINS, HOUSEHOLD APPLIANCES, RADIOS, TELEVISIONS, AND MUSICAL SUPPLIES.	4.6
591	**DRUGSTORES AND PROPRIETARY STORES** SALE OF PRESCRIPTION DRUGS, COSMETICS, TOILETRIES AND TOBACCO.	3.2

SOURCES: EOP/OMB: STANDARD INDUSTRIAL CLASSIFICATION MANUAL, 1972
A.D. LITTLE, INC.

TABLE 14-4

SUBDIVISIONS AND CHARACTERIZATION OF
TRADE-MERCHANT WHOLESALERS DURING 1977, IN 1972 DOLLARS
(DURABLE GOODS)

SUBDIVISION	PERCENTAGE CONTRIBUTION	SALES (BILLION $)	EMPLOYEES (1,000)	ESTABLISHMENTS	INVENTORY (BILLION $)	GROSS VALUE OF FIXED ASSETS ($/EMPLOYEE)	NEW CAPITAL EXPENDITURES ($/EMPLOYEE)	LABOR PRODUCTIVITY ($/EMPLOYEE)
ALL DURABLE GOODS (50)	100.0	212.3	1955	184,000	46.1	8405	1337	26,100
MOTOR VEHICLES AND AUTO PARTS (501)	18.5	39.3	351	36,000	8.1	6006	855	22,600
FURNITURE AND HOME FURNISHINGS (502)	3.7	7.9	89	8,000	1.6	4621	705	22,800
LUMBER AND CONST. MATERIALS (503)	9.3	19.7	144	13,000	2.7	11307	1661	31,200
SPORTING, PHOTO, AND HOBBY GOODS (504)	2.7	5.8	58	5,000	1.6	5742	770	25,400
METALS AND MINERALS (505)	11.5	24.4	107	7,000	5.1	21064	5248	42,600
ELECTRICAL GOODS (506)	10.2	21.7	194	17,000	4.4	5827	904	26,000
HARDWARE, PLUMBING AND HEATING (507)	6.7	14.2	165	15,000	3.2	5691	743	22,400
MACHINERY EQUIPMENT, & SUPPLIES (508)	28.8	61.2	697	68,000	16.5	8123	1617	25,300
MISC. DURABLE GOODS (509)	8.6	18.1	148	15,000	3.0	13180	1712	27,000

SOURCES: A.D. LITTLE, INC.
U.S. DOC/BOC: CENSUS OF WHOLESALE AND RETAIL TRADE, 1977

TABLE 14-5

SUBDIVISIONS AND CHARACTERIZATION OF TRADE-MERCHANT WHOLESALERS DURING 1977, IN 1972 DOLLARS (NONDURABLE GOODS)

SUBDIVISION	PERCENTAGE CONTRIBUTION	SALES (BILLION $)	EMPLOYEES (1,000)	ESTABLISHMENTS	INVENTORY (BILLION $)	GROSS VALUE OF FIXED ASSETS ($/EMPLOYEE)	NEW CAPITAL EXPENDITURES ($/EMPLOYEE)	LABOR PRODUCTIVITY ($/EMPLOYEE)
ALL NON-DURABLE GOODS (51)	100.0	267.4	1413	123,000	26.2	12,548	1780	28,700
PAPER AND PAPER PRODUCTS (511)	4.0	10.7	114	9,000	1.2	4108	738	23,200
DRUGS AND DRUG PROPRIETARIES (512)	2.7	7.2	62	3,000	1.3	4784	729	24,000
APPAREL AND PIECE GOODS (513)	4.8	12.8	96	10,000	2.6	4074	615	31,800
GROCERIES AND RELATED PRODUCTS (514)	29.8	80.0	452	29,000	--	11,573	1606	26,300
FARM PRODUCTS RAW MATERIALS (515)	21.4	57.3	97	12,000	6.0	39,836	5675	40,000
CHEMICALS AND ALLIED PRODUCTS (516)	2.6	7.1	53	6,000	0.7	12,010	1835	37,600
PETROLEUM AND PETROLEUM PRODUCTS (517)	15.9	42.5	131	16,000	2.1	21,974	3009	36,400
BEER, WINE, AND DISTILLED PRODUCTS (518)	--	16.0	112	6,000	1.9	8884	1452	34,200
MISC. NON-DURABLE GOODS (519)	6.0	34.2	295	32,000	4.3	9971	1360	23,700

-- NOT AVAILABLE

SOURCE: A.D. LITTLE, INC.
U.S. DOC/BOC: CENSUS OF WHOLESALE AND RETAIL TRADE, 1977

TABLE 14-6

SUBDIVISIONS AND CHARACTERIZATION OF
RETAIL TRADE SERVICE (SIC 52-59) DURING 1977, IN 1972 DOLLARS

SUBDIVISION	PERCENTAGE CONTRIBUTION	SALES (BILLION $)	EMPLOYEES (1,000)	ESTABLISHMENTS	INVENTORY (BILLIONS $)	GROSS VALUE OF FIXED ASSETS ($/EMPLOYEE)	NEW CAPITAL EXPENDITURES ($/EMPLOYEE)	LABOR PRODUCTIVITY ($/EMPLOYEE)
ALL RETAIL TRADE (52-59)	100.0	517.8	13,040	--	87.4	5276	776	11,400
BUILDING MATERIALS, HARD-WARE, & SUPPLIES (52)	5.4	27.7	470	90,000	7.2	6656	968	16,700
GENERAL MERCHANDISE (53)	12.5	64.8	2,017	49,000	15.7	5631	681	11,600
FOOD STORES (54)	21.8	112.8	1,959	252,000	9.5	6260	918	12,200
AUTOMOTIVE DEALERS (55 EX. 554)	20.7	107.1	1,115	139,000	22.1	4314	653	13,500
GASOLINE SERVICE STATIONS (554)	7.8	40.3	673	176,000	1.8	7178	1015	11,300
APPAREL AND ACCESSORY STORES (56)	4.9	25.4	840	140,000	1.8	4151	405	12,600
FURNITURE AND HOME FURNISHINGS (57)	4.6	23.7	513	139,000	7.3	5315	--	16,400
EATING AND DRINKING PLACES (58)	8.7	45.2	3,759	368,000	6.5	4125	659	6,300
DRUG AND PROPRIETARY STORES (591)	10.4	16.6	450	50,000	1.5	3569	479	10,800
MISCELLANEOUS RETAIL STORES (59 EX. 591)	3.2	54.3	1,235	--	13.8	7329	--	--

-- NOT AVAILABLE

SOURCES: A.D. LITTLE, INC.
U.S. DOC/BOC: CENSUS OF WHOLESALE AND RETAIL TRADE, 1977

- Gross value of fixed assets/employee during 1977 (1972 $) ranged from a high of $12,548 for merchant wholesalers of nondurable goods to a low figure ($5,276) for retail trade.

- A high amount of inventory, $160 billion during 1977 (1972 $), which totaled 16% of sales for all groups combined.

- A value added of $41 billion and $149 billion for merchant wholesaling and retailing, respectively, as compared to $418 billion of value added for all manufacturing subsectors during 1977 (1972 $).

Durable and nondurable goods were developed primarily for economic analysis of manufacturing output. Durables are normally capitalized by businesses who buy them whereas nondurables are considered expenses. Hence, the manufactured output of durables adds to the capital base of the economy.

The terms durable and nondurable are used to categorize merchant wholesalers but usually not retailers. Since many merchant wholesalers represent specific manufacturers and manufacturing sectors producing only durable or nondurable goods, but not both, this transfer is natural. Generally, economists cannot group retailer categories into durable and nondurable categories due to the integration of goods at the retail level.

Groceries and related products (SIC 514) accounted for 16.6% of all merchant wholesale trade sales in 1977 and was the largest subdivision of all wholesale trade subsectors. Food stores (SIC 54) accounted for 21.8% of all retail trade sales in 1977 and was the largest retail subsector. In assessing long-term technology needs, these two areas have been selected for further analysis.

B.14.1 GROCERIES AND RELATED PRODUCTS (SIC 514)

The principal business of the food wholesaler is to purchase food stuffs from growers, processers and manufacturers and distribute it to grocery stores, restaurants, hospitals, schools, and other institutions. Inventory is maintained and processed in warehouses, then shipped via truck to customers.

The subdivision's historical and current posture is summarized in Tables 14-7 and 14-8, which portray the business and structural profiles, respectively. Table 14-7 shows that sales have increased 26% in five years from $12.1 billion in 1979 to $15.2 billion in 1983 (1972 $). The 1984 estimate of $16.7 billion in sales is a 10% increase from the previous year. Inventory costs have risen from $892 million (1972 $) in 1979 to $948 million (1972 $) in 1983, a jump of 6%. Net profit margin has hovered between 1.0% and 0.9% from 1979 to 1984.

Table 14-8 shows that the subdivision is dominated by ten firms, including Super Valu Stores which is the leading grocery wholesaler in the nation. All of the top ten firms have more than 1,800 employees.

There are three dominant factors which influence/constrain the grocery wholesaler service listed in Table 14-9. First, the industry is affected by consumer safety laws which hold the wholesaler liable for the products causing harm to customers, irrespective of negligence or fault. Another problem faced by grocery wholesalers is bankruptcy reform. Wholesale customers can file for bankruptcy under Chapters 7 and 11 of the Federal Bankruptcy Act, and then reorganize under a new corporate identity while retaining unpaid merchandise from the wholesaler. Thirdly, multi-employer pension plans have adversely affected wholesalers by draining funds for employees they no longer have.

TABLE 14-7

BUSINESS PROFILE OF GROCERIES AND RELATED PRODUCTS (SIC 514)

SALES (BILLION $)	1979	1980	1981	1982	1983	1984 EST.
CURRENT	19.7	23.5	26.5	28.7	32.0	36.0
1972 $	12.1	13.2	13.6	13.9	15.2	16.7
INVENTORY						
MILLION 1972 $	892	941	918	948	948	1,023
INVENTORY TURNOVER	13.4	14.0	14.8	14.6	16.0	16.5
NET PROFIT MARGIN %	1.0	1.0	0.9	0.9	1.0	1.0

SOURCES: U.S. DOC/BIE: 1984 U.S. INDUSTRIAL OUTLOOK
VALUE-LINE INVESTMENT SURVEY, 1984

TABLE 14-8

STRUCTURAL PROFILE OF GROCERIES AND RELATED PRODUCTS (SIC 514)

LEADING FIRMS (1983)	SALES (MILLION 1972 $)	NET PROFIT MARGIN (%)	NUMBER OF EMPLOYEES
SUPER VALU STORES	2796	1.47	21,391
FLEMING CO., INC.	2321	0.89	11,900
WETTERAU, INC.	1303	1.0	7,600
MALONE AND HYDE, INC.	1233	1.47	11,000
SYSCO CORP.	931	2.2	7,500
FARM HOUSE FOODS	723	0.48	4,500
FLICKINGER CO.	700	0.87	7,025
SUPER FOOD SERVICES	581	0.62	1,852
CFS CONTINENTAL	558	1.4	4,500
SCOT LAD FOODS	427	0.75	2,400

	1970	1975	1979	1980	1981
NUMBER OF BUSINESS FAILURES (ALL SIC 50 & 51)	984	1,089	908	1,284	1,709

	1977
NUMBER OF ESTABLISHMENTS (ALL MERCHANT WHOLESALERS) (THOUSANDS)	307.3
PAYROLL (ALL MERCHANT WHOLESALERS) (MILLION $)	42

SOURCE: U.S. DOC/BOC: STATISTICAL ABSTRACT OF THE U.S., 1984
VALUE-LINE INVESTMENT SURVEY, 1984

TABLE 14-9

DOMINANT CONSTRAINTS AFFECTING THE GROCERY WHOLESALER SERVICE (SIC 50-51)

PRODUCT LIABILITY	PROVIDES COMPENSATION TO CONSUMER INJURED BY A PRODUCT SOLD BY THE WHOLESALER. COST OF INSURANCE IS VERY EXPENSIVE AND DOES NOT PROVIDE FULL COVERAGE.
BANKRUPTCY REFORM	CLIENTS AND SUPPLIERS WITH SUBSTANTIAL FUTURE EARNINGS POTENTIAL FILE FOR BANKRUPTCY UNDER CHAPTERS 7 AND 11 OF THE FEDERAL BANKRUPTCY ACT, CAUSING SUBSEQUENT LOSS OF PRODUCTS AND REVENUE FOR THE WHOLESALER.
MULTI-EMPLOYER PENSION PLAN ACT	WHOLESALERS MUST CONTINUE TO BE LIABLE TO A MULTI-EMPLOYER PENSION PLAN IN SPITE OF FACILITY SHUTDOWNS, WORKFORCE REDUCTIONS, STRIKES, UNION DECERTIFICATION, SALES OF BUSINESSES, OR NATURAL DISASTERS.

SOURCE: U.S. DOC/BIE: 1984 U.S. INDUSTRIAL OUTLOOK.

Competitive Issues Affecting the Grocery Wholesaler Service

The U.S. merchant wholesale trade is relatively unaffected by foreign trade competition. Rather, competition from domestic concerns, i.e., other types of wholesalers and the retail trade industry plays a more important role. In general, merchant wholesalers will continue to dominate the market, increasing their market share from 54% in 1977 to 58% in 1990.

Productivity in the Grocery Wholesaler Service

The labor productivity (see Table 14-5) for grocery wholesalers was at $26,300 during 1977 (1972 $) while the productivity for all nondurable goods was 9% greater at $28,700 (1972 $). The largest expense for the service is maintaining inventory, 5.4% of sales in 1977. New capital expenditures per employee was $1,606 during 1977 (1972 $), 10% below the service sector's average of $1,780 (1972 $).

Role of Technology in Long-Term Strategic Outlook

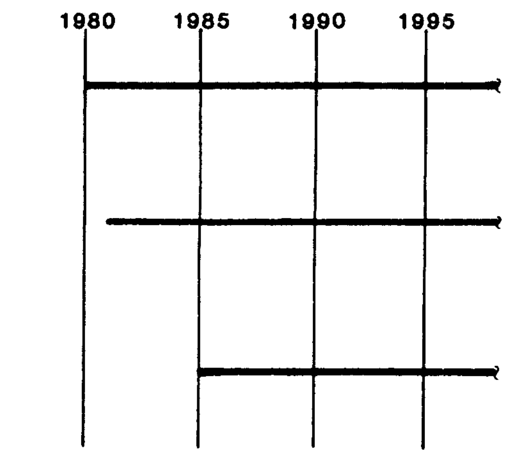
The grocery wholesaler subdivision seems to be saturated with respect to future growth rates. As the amount of the subdivision products sold are definitely population related, growth will be limited by the growth of the population. However, increases in productivity can be made in some areas. Table 14-10 indicates major technology changes within the subdivision that will increase productivity. These changes fall into two categories:

- **Informational efficiency**--pertains to enhanced communication between manufacturer, wholesaler, and retailer;

- **Physical efficiency**--location and efficiency of warehousing.

TABLE 14-10

MAJOR TECHNOLOGY CHANGES WITHIN THE GROCERY WHOLESALER SERVICE

TECHNOLOGY	DESCRIPTION	PRINCIPAL IMPACT	APPROXIMATE ERA OF SIGNIFICANT DIFFUSION
CODING	NUMERIC CODES TO UNIQUELY IDENTIFY ALL TYPES OF PRODUCTS TO ENHANCE FASTER COMMUNICATION BETWEEN RETAILER, WHOLESALER, AND MANUFACTURER.	FASTER AND MORE RELIABLE SERVICE TO RETAIL CUSTOMERS.	
COMPUTERS	DIRECT PLACEMENT OF CUSTOMER ORDERS, INVENTORY ADJUSTMENTS, AND SPEEDIER BILLING TECHNIQUES.	FASTER AND MORE RELIABLE SERVICE TO RETAIL CUSTOMERS.	
WAREHOUSING	NEW STRUCTURES PLACED ON MAJOR THROUGHFARES TO BETTER SERVICE MARKETS. STANDARD CASE MEASUREMENTS, SHRINK WRAP PALLETS, PLASTIC CONTAINERS, AUTOMATED CONSOLE CONTROLLED INTERFACED CONVEYOR & STACKER/RETRIEVER SYSTEM.	WILL REDUCE SPACE AND UNSKILLED LABOR NEEDS.	

SOURCES: U.S. DOC/BIE: 1984 U.S. INDUSTRIAL OUTLOOK
U.S. DOL/BLS: BULLETIN #1856

Universal coding of all products for unique identification will enhance faster communication and more reliable service between manufacturer, wholesaler, and retailer. It will also reduce the amount of clerical help needed. The introduction of computers will enable direct placement of customer orders, inventory adjustments, and faster billing techniques. Warehousing may also be improved through the use of standardized case measurements, shrink wrap pallets, and plastic containers to enable the implementation of automated console controlled interfaced conveyor and stacker/retriever system. This system will reduce space and unskilled labor needs. Also, better location of new warehouses (near major throughfares) will provide easier access to market areas.

Introduction of these technologies could reduce costs in the industry, such as inventory backlog, labor and shipping. Universal product codes coupled with automated warehousing could cut physical labor costs and computer information systems would increase inventory turnover.

Conclusion

The grocery wholesaler's principal business is to supply retailers and institutions with foodstuffs and related items. The industry is adversely affected by consumer safety laws, bankruptcy reform, and multi-employer pension plans. There is virtually no foreign trade competition, but there is competition from direct factory outlets. Productivity is high in the subdivision at $26,300 (1977, 1972 $) per employee.

New technology seems to be aimed at improving current techniques used in the grocery retailing service. Coding of products, computerization and automated warehousing will all continue to improve productivity. The basic structure of the industry, however, will remain unchanged.

B.14.2 FOOD STORES (SIC 54)

This subsector includes establishments that retail all types of food products along with related items. The food stores subsector accounted for 16% of the added value in the retail trade service during 1977. In recent years, many grocery chains retrenched, closing marginal stores and distribution centers. Employees agreed to hold wages constant in return for job security. The effects of these cost cutting measures have been reflected in the ratio of net profits to sales which reached 1.7% in 1983 as compared to 1.6% in 1982.

The subsector's historical and current posture is summarized in Tables 14-11 and 14-12, which portray the industry's business and structural profiles, respectively. Table 14-11 shows that, expressed in 1972 dollars, sales have increased 33% in eleven years from $93.3 billion in 1972 to $124 billion in 1983. The bulk of the increased sales (31%) was seen in the seven year period from 1972 to 1979. A small gain of only 2% in sales was realized in the period from 1979 to 1983. Employment has steadily increased, rising by 39% from 1.8 million in 1972 to 2.5 million in 1983. Labor productivity, i.e., output per employee hour increased at an average annual rate of 0.3% between 1977 and 1982.

Table 4-12 shows that the food store service is comprised of many firms, the largest of which accounted for 16% of total sales in 1983. The top ten firms accounted for 84% of total sales in food store service for 1983.

As shown in Table 14-12, inventory in a grocery store turned over an average of 14 times in 1983, up 9% from 12.9 in 1972. This would indicate a higher productivity and better management of resources.

TABLE 14-11

BUSINESS PROFILE OF THE FOOD STORE SERVICE (SIC 54)

	1972	1977	1979	1981	1983
SALES (BILLIONS)					
CURRENT $	93.3	158	199	241	262
1972 $	93.3	113	122	124	124
TOTAL EMPLOYMENT (MILLIONS)	1.8	2.1	2.3	2.4	2.5
AVERAGE HOURLY EARNINGS NONSUPERVISORY (1972 $)	3.09	3.41	3.47	3.51	3.52

RELATIVE CONTRIBUTION TO VALUE ADDED

	1977
	18.0%

SOURCES: U.S. DOC/BIE: 1984 U.S. INDUSTRIAL OUTLOOK
U.S. DOC/BOC: CENSUS OF WHOLESALE AND RETAIL TRADE, 1977
U.S. DOL/BLS
VALUE-LINE INVESTMENT SURVEY, 1984

TABLE 14-12

STRUCTURAL PROFILE OF THE FOOD STORE SERVICE (SIC 54)

LEADING FIRMS (1983)	TOTAL SALES (BILLION 1972 $)	NO. OF ESTABLISHMENTS
KROGER CO.	7.2	2450
SAFEWAY STORES	6.5	2100
SOUTHLAND CORP.	4.3	9000
LUCKY STORES	4.0	1950
AMERICAN STORES	3.8	1140
WINN-DIXIE	3.3	1325
JEWEL CO.	2.7	1525
A & P	2.5	1200
ALBERTSON'S INC.	2.1	595
SUPERMARKETS GENERAL	1.4	250

INVENTORY TURNOVER	1979	1980	1981	1982	1983
	12.9	13.6	14.2	13.7	14.0

AVERAGE SQ. FT. FLOOR SPACE	1979	1984
	25,000	32,000

RETAIL ADVERTISING-NEWSPAPERS (ALL SIC 52-59) (MILLION $)	1970	1975	1977	1979	1981
	1,759	2,364	3,129	4,040	5,068

CONSUMER CREDIT OUTSTANDING (ALL SIC 52-59) (MILLION $)	1970	1975	1977	1979	1981
	13.9	18.2	23.5	28.1	29.6

SOURCES: U.S. DOC/BIE: 1984 U.S. INDUSTRIAL OUTLOOK
U.S. DOC/BOC: CENSUS OF WHOLESALE AND RETAIL TRADE, 1977
U.S. DOC/BOC: STATISTICAL ABSTRACT OF THE U.S., 1984
VALUE-LINE INVESTMENT SURVEY, 1984

Significant structural changes are occurring in the food stores service currently. The average square feet floor space (Table 14-12) has risen from 25,000 square feet in 1977 to 32,000 square feet in 1984, an increase of 28%. This is due to the ability of the larger stores to carry many high margin nonfood and specialty food items, on which price markups may approach 70%. Most major grocery store chains have focused on this expansion to strengthen their financial position.

Among the factors which influence/constain the industry, three are dominant, as shown in Table 14-13. The service will be affected by slow population growth through the 1980s. The price of food, influenced by natural disasters and other unforeseen problems, directly affects the service. Due to consumer demands, checkcashing is an essential customer service, and the food stores lose millions of dollars in layover interest.

TABLE 14-13

DOMINANT CONSTRAINTS AFFECTING THE FOOD STORES SERVICE

SLOW POPULATION GROWTH	PRINCIPAL DRIVING FORCE BEHIND FOOD SALES IS POPULATION. TOTAL POPULATION EXPECTED TO INCREASE ONLY 1% ANNUALLY OVER NEXT 5 YEARS.
FOOD PRICES	RISING FOOD PRICES FORCE CONSUMERS TO BUY CHEAPER GENERIC BRANDS (LESS MARK-UP) AS OPPOSED TO MORE EXPENSIVE GOURMET FOODS. PRICE RISES ARE OUT OF THE RETAILERS' CONTROL.
CASH LOSSES DUE TO "CHECK-FLOAT"	FOOD RETAILERS CASH MORE CHECKS THAN BANKS. IN THE 7 TO 10 DAY PERIOD BEFORE THE BANK CREDITS THE RETAILER'S ACCOUNT, MILLIONS OF DOLLARS IN INTEREST ARE LOST.

Competitive Issues Affecting the Food Store Service

Due to the subsector structure and customer base there is very little foreign competition. However, domestic competitiion is very intense. Retail companies spent an estimated $2 billion (1972 $) in 1983 on advertising.

Productivity in the Food Store Service

As stated earlier, output per employee hour increased at an average annual rate of 0.3% from 1977 to 1982. As shown in Table 14-11, nonsupervisory hourly earnings (1972 $) in 1972 were $3.09 and rose to $3.52 by 1983, an increase of 14%. Recently, the total number of employees has leveled off (a 4% increase from 1981 to 1983) due to increased labor efficiencies from scanning and other computer-related technologies. During 1977, food store service productivity (Table 14-6), at $12,200 (1972 $), was 7% greater than the average for all retail trade at $11,400 (1972 $). New capital expenditures per employee of $918 (1972 $) were 18% larger than the industry average, showing the increased investment in the computerized functions.

Role of Technology in Long-Term Strategic Outlook

Food store services have traditionally made use of new technological advances. Recently, food stores have become large, specialized distribution centers to the retail market. However, since market demand is based on population, slow population growth has caused this subsector to reach saturation as indicated by the recent small productivity increases. The low labor productivity shows potential for improvement using advanced technological developments.

New Technologies in the Food Store Service

Table 14-14 summarizes the technologies currently being developed and planned. They fall into two groups:

- More efficient conventional food stores through the use of electronic cash registers, computer functions, microfilming records, installation of automated teller machines and electronic fund transfer apparatus, and supermarket automation using U.P.C. codes and optical scanners.

- Personal shopping at home using videodiscs and cable television by viewing, ordering and paying for items electronically through use of an integrated two-way live presence videodisc/CATV system.

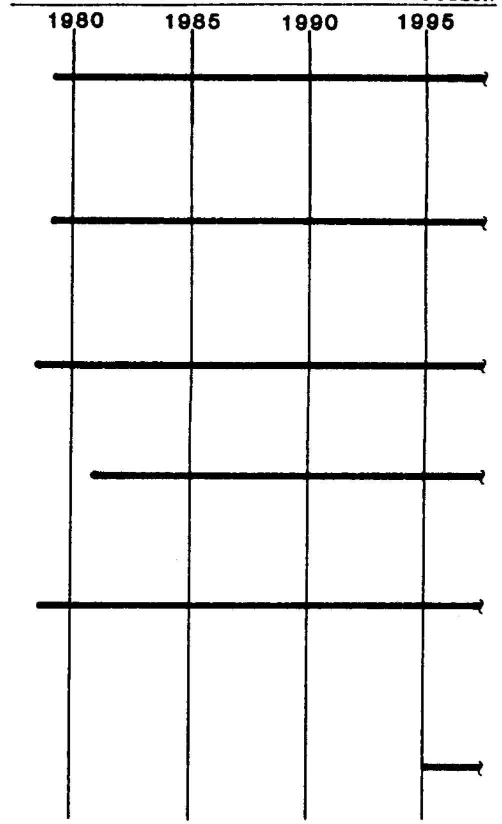
The first group of technologies would enhance the capabilities of our current retail system. These improvements could drastically increase productivity levels. Many of these technologies such as scanners are already in heavy use. The FDA estimates that 20,000 scanner systems handling about 50% of all retail food purchases will be operational by 1987.

The second group entails the use of shop at home services which would reduce the need for stores. With many products there is a need to see how they perform, to judge their appearance, feel, color and texture. This concept could be expanded for use in all retail trade. A customer could apply a broad range of his sensory facilities via remote live presence. Remote sensing that could work in reverse and accurately measure a customer's size requirement or personal tastes, and coupled with CAD/CAM, could provide personalized manufacturing of clothing and other items. By these means, the need for investments in inventory and local storage and selling facilities will be eliminated in many situations.

TABLE 14-14

MAJOR TECHNOLOGY CHANGES WITHIN THE FOOD STORE SERVICE

TECHNOLOGY	DESCRIPTION	PRINCIPAL IMPACT	APPROXIMATE ERA OF SIGNIFICANT DIFFUSION
ELECTRONIC CASH REGISTERS AND VENDOR SOURCE-MARKED MERCHANDISE IDENTIFICATION TICKETS	TERMINALS READ MAGNETICALLY MARKED ITEMS AND AUTOMATICALLY TABULATES PRICE AND RECALCULATES INVENTORY.	REDUCE TIME OF ENTERING DATA INTO TERMINALS SAVE LABOR COSTS.	
ADDITIONAL COMPUTER FUNCTIONS	CUSTOMER CHARGE ACCOUNT CREDIT, BANK CHECK AUTHORIZATION, AND INVENTORY NEEDS AUDITED DIRECTLY FROM ELECTRONIC CASH REGISTER.	REDUCE CASH LOSSES DUE TO "CHECK-FLOAT," REDUCE LABOR OF SALESPERSONS.	
MICROFILMING	MAINTAINS INTERNAL RECORDS AND DISTRIBUTES INFORMATION TO MULTIPLE LOCATIONS FOR DISPLAY ON VIEWERS.	BETTER CUSTOMER SERVICE, REDUCE LABOR OF SALESPERSONS AND CLERKS.	
INSTALL ATMs & EFTs	AUTOMATED TELLER MACHINES AND ELECTRONIC FUND TRANSFER APPARATUS.	REDUCE CASH LOSSES DUE TO "CHECK-FLOAT."	
SUPERMARKET AUTOMATION	UNIVERSAL PRODUCT CODE PROVIDES UNIQUE I.D. FOR EACH PRODUCT & AN OPTICAL SCANNER READS CODE, FLASHES PRICE ON SCREEN, AND TRANSMITS INFORMATION TO A CENTRAL COMPUTER.	30% INCREASE IN CHECK-OUT SPEED, 10-15% REDUCTION IN LABOR REQUIREMENTS.	
PERSONAL SHOPPING WITH VIDEODISCS AND CATV	SHOPPING WITHOUT STORES BY VIEWING, ORDERING, AND PAYING FOR MERCHANDISE ELECTRONICALLY THROUGH USE OF AN INTEGRATED VIDEODISC/CATV SYSTEM.	DRASTICALLY CHANGE THE RETAIL MARKET-CUSTOMERS WILL NO LONGER SHOP IN STORES, BUT AT HOME.	



SOURCES: U.S. DOC/BIE: 1984 U.S. INDUSTRIAL OUTLOOK
U.S. DOC/BLS: BULLETIN #1961

This technology is addressed in detail in Section E.10, "Live-Presence Communications."

Conclusion

Food stores retail all types of food items and related items to the end user. The industry is constrained by a slow growth in demand (tied to population growth), fluctuating food prices, and cash losses due to "check-float" (lag time between checks being cashed and accounts being credited). Productivity has been increased in recent years due to automatic scanners and other computerization.

The prospect of live presence communication could drastically change the industry. Consumers could conceivably do all of the their shopping from their homes and eliminate the need for most retail stores. This would save labor and capital, and increase productivity.

B.15 "GOVERNMENT AND GOVERNMENT ENTERPRISES" (SIC 90-97)

TABLE OF CONTENTS

SOURCES: U.S. DOC/BOC:

Statistical Abstract of the U.S., 1984

Census of Governments, 1977

EOP/OMB:

Standard Industrial Classification Manual, 1972

UNESCO:

Statistical Yearbook, 1983

LIST OF TABLES

LIST OF FIGURES

B.15 "GOVERNMENT AND GOVERNMENT ENTERPRISES" (SIC 90-97)

The government and government enterprises subsectors (SIC 90-97), represented 20% of the U.S. GNP in terms of purchases, and 14% of the U.S. GNP in terms of total contribution in 1980. These subsectors will be treated by function rather than by the SIC codes shown in Table 15-1, because of the nature of the available data.

The government purchases portion of the GNP increased from 10.7% in 1930 to 21.1% in 1982, as shown in Figure 15-1. The overall size of these subsectors is equivalent to 80% of all manufacturing subsectors combined. The federal government accounted for 52.6% ($257 billion) of total direct government expenditures during 1977, in 1972 dollars; state governments accounted for 18.9% ($92 billion); local governments accounted for 28.5% ($13 billion).

As shown in Figure 15-2, total government employment increased from 6.4 million in 1950 (10.9% of employed labor force) to 15.9 million in 1982 (16% of employed labor force). Federal employment (civilian only), however, dropped from 3.5% of the employed labor force in 1950 to 2.9% in 1982. State government employment rose from 1.8% of the employed labor force in 1950 to 3.8% in 1982; local government saw the sharpest rise, increasing from 5.5% of the employed labor force in 1950 to 9.4% in 1982.

Federal Government Enterprises

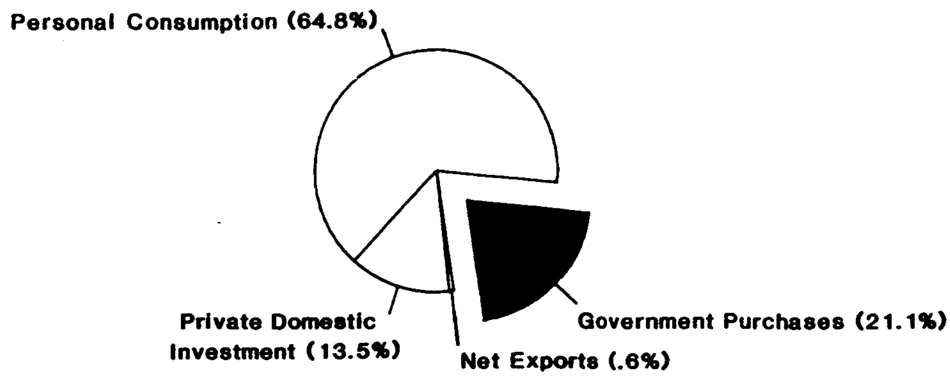
Direct federal expenditures of $257 billion during 1977, (in 1972 $), totaled 52.6% of all direct government expenditures. Figure 15-3 shows that insurance trust expenditures (employee retirement, unemployment compensation, disability and health insurance, veterans life insurance, railroad retirement) of $84 billion (1972 $) were the largest federal expenditures (31.2%).

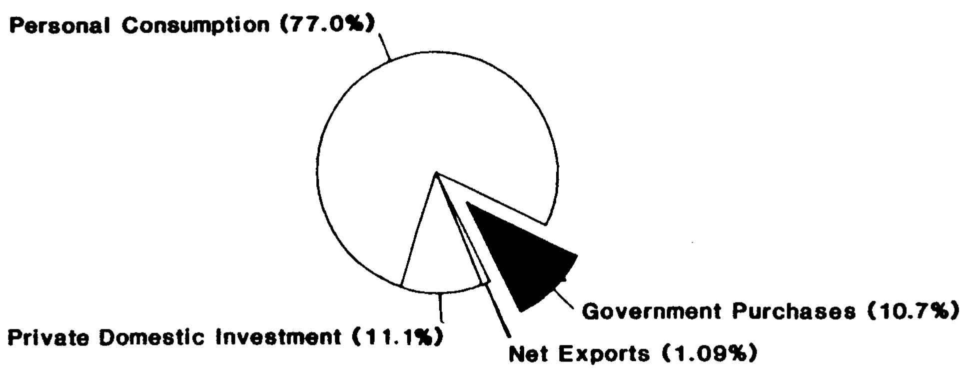
TABLE 15-1

STANDARD INDUSTRIAL CLASSIFICATION OF FUNCTIONS ASSOCIATED WITH PUBLIC ADMINISTRATION

SIC CODE	
91	**EXECUTIVE, LEGISLATIVE, AND GENERAL**
911	EXECUTIVE OFFICES
912	LEGISLATIVE BODIES
913	EXECUTIVE AND LEGISLATIVE COMBINED
919	GENERAL GOVERNMENT, NEC
92	**JUSTICE, PUBLIC ORDER, AND SAFETY**
921	COURTS
922	PUBLIC ORDER AND SAFETY
9221	POLICE PROTECTION
9222	LEGAL COUNSEL AND PROSECUTION
9223	CORRECTIONAL INSTITUTIONS
9224	FIRE PROTECTION
93	**FINANCE, TAXATION & MONETARY POLICY**
931	FINANCE, TAXATION & MONETARY POLICY
94	**ADMINISTRATION OF HUMAN RESOURCES**
941	ADMINISTRATION OF EDUCATIONAL PROGRAMS
943	ADMINISTRATION OF PUBLIC HEALTH PROGRAMS
944	ADMINISTRATION OF SOCIAL & MANPOWER PROGRAMS
945	ADMINISTRATION OF VETERANS' AFFAIRS
95	**ENVIRONMENTAL QUALITY AND HOUSING**
951	ENVIRONMENTAL QUALITY
9512	LAND, MINERAL, WILDLIFE CONSERVATION
953	HOUSING AND URBAN DEVELOPMENT
9531	HOUSING PROGRAMS
9532	URBAN AND COMMUNITY DEVELOPMENT
96	**ADMINISTRATION OF ECONOMIC PROGRAMS**
961	ADMINISTRATION OF GENERAL ECONOMIC PROGRAMS
962	REGULATION, ADMINISTRATION OF TRANSPORTATION
963	REGULATION, ADMINISTRATION OF UTILITIES
964	REGULATION OF AGRICULTURAL MARKETING
965	REGULATION MISC. COMMERCIAL SECTORS
966	SPACE RESEARCH AND TECHNOLOGY
97	**NATIONAL SECURITY AND INTERNATIONAL AFFAIRS**
971	NATIONAL SECURITY
972	INTERNATIONAL AFFAIRS

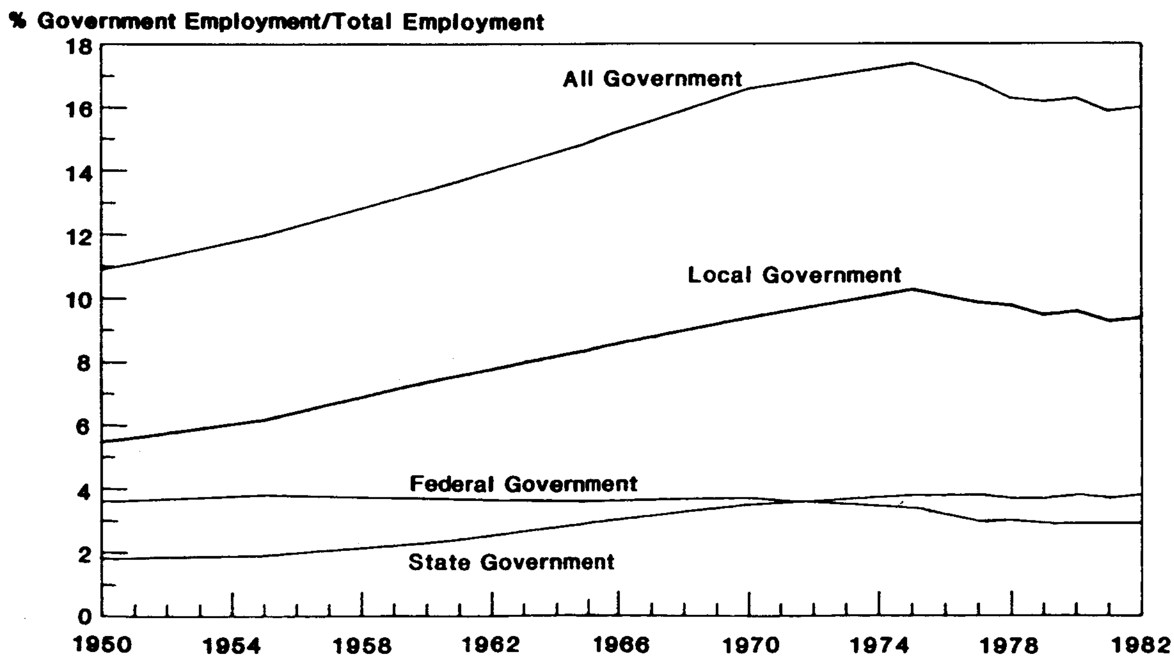
SOURCE: EOP/OMB: STANDARD INDUSTRIAL CLASSIFICATION MANUAL, 1972





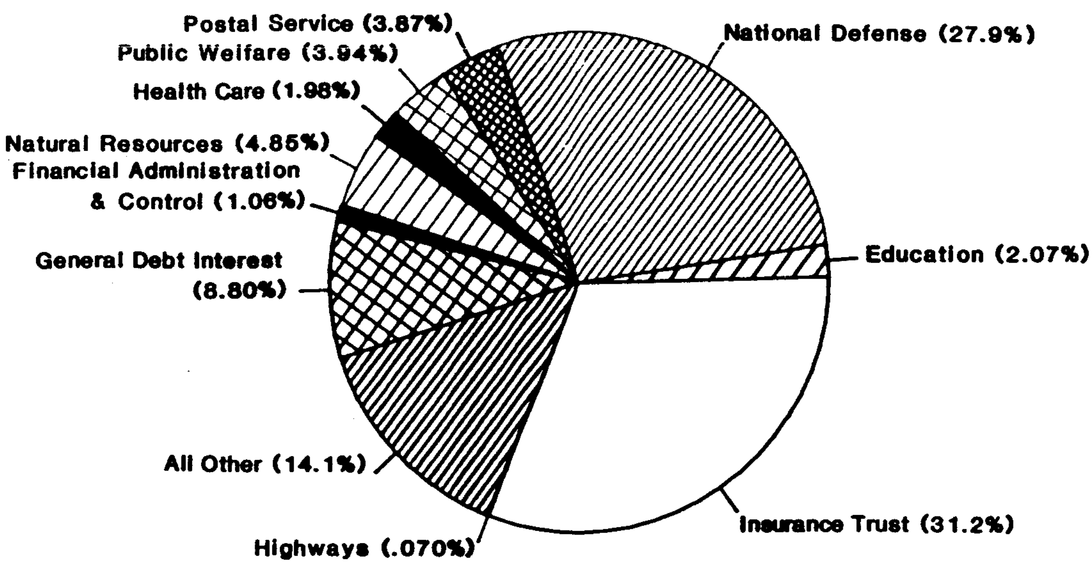
Source: Statistical Abstract of the United States,
1984, U.S. Department of Commerce,
Bureau of Labor Statistics.

Figure 15-1. Gross National Product: 1982 Versus 1930



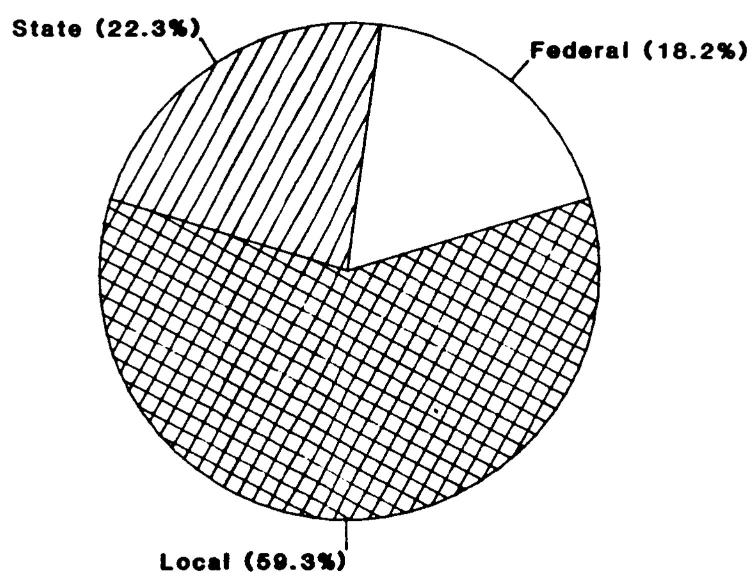
Source: Statistical Abstract of the United States, 1984,
U.S. Department of Commerce, Bureau of the Census.

Figure 15-2. Government Employment/Total Employment 1950-1982



Source: 1977 Census of Governments,
Department of Commerce,
Bureau of the Census.

Figure 15-3. Percent Distribution of Direct Expenditure, by Function, for Federal Government, 1977



Source: 1977 Census of Governments,
Department of Commerce,
Bureau of the Census.

Figure 15-4. Percent of Public Employees (Full & Part Time) by Level of Government, 1977

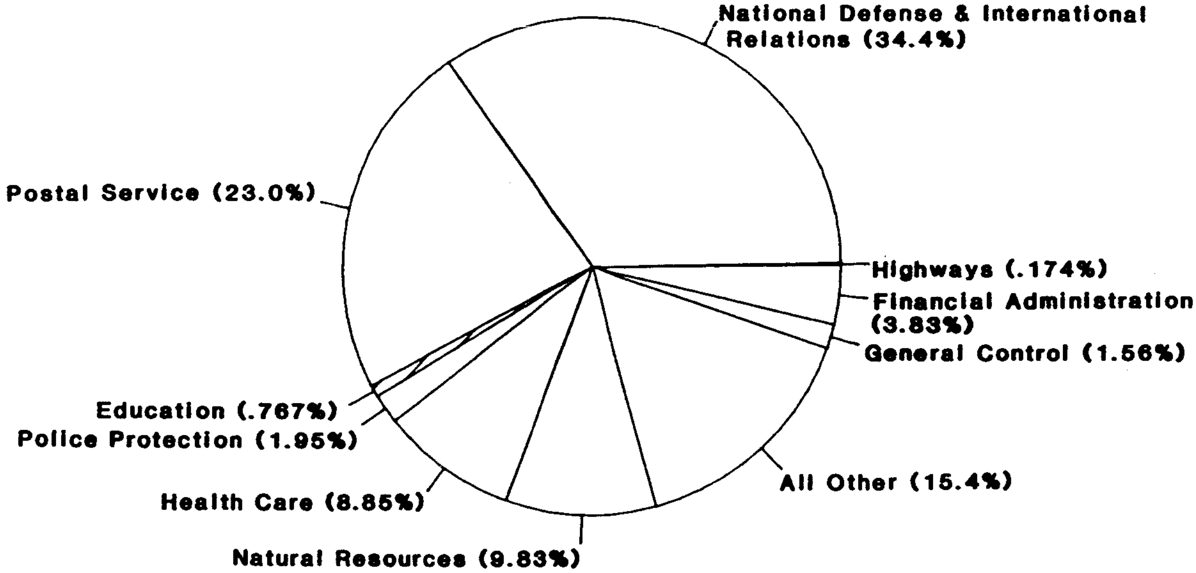
National defense expenditures of $75 billion accounted for 27.9%; interest on the general debt accounted for 8.8% or $34 billion (1972 $) of federal expenditures.

Figure 15-4 shows that the federal government employed 18.2% of public employees or 2.8 million persons during 1977 (3% of the employed labor force). National defense (excluding the military) and international relations employed one million persons (34.4% of total federal employment); the postal service, with 660,000 employees (23.0%) was second; and natural resources, with 280,000 employees, was third (9.8%), see Figure 15-5. Employment trends over the 32-year period from 1950 to 1982 show a 0.6% drop in federal employment when compared to the total employed labor force.

State Government Enterprises

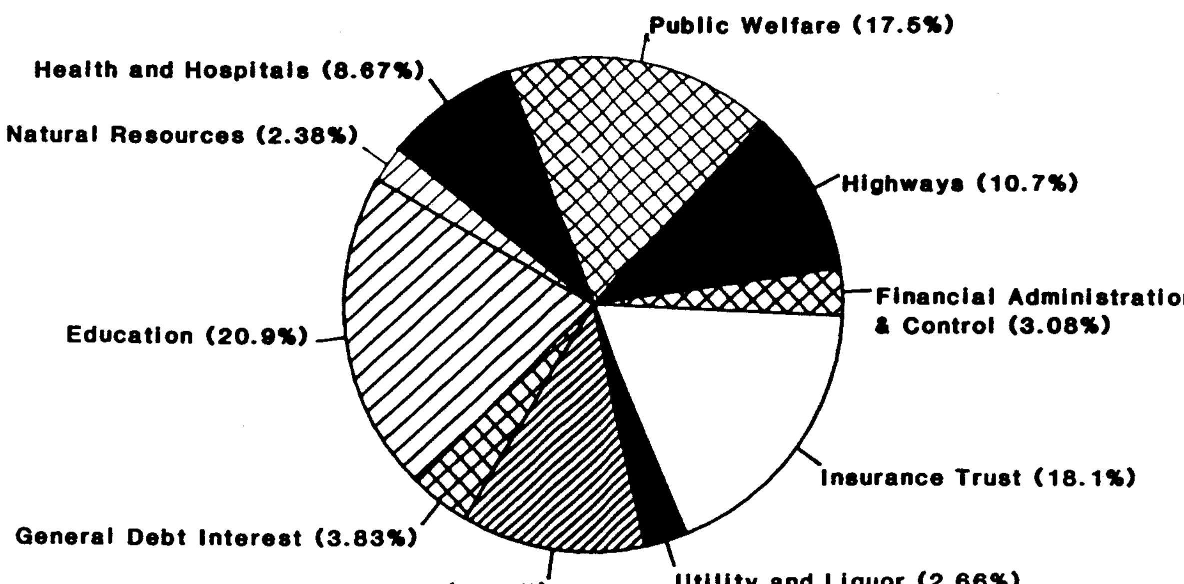
As shown in Figure 15-6, education received $19 billion or 20.9% of the direct state government expenditures in 1977 (1972 $), with 78% of these expenditures earmarked for institutions of higher learning. Public welfare received $16 billion which accounted for 17.5% of direct state expenditures, while insurance trust expenditures (employee retirement, unemployment compensation) totaled 18.1% of state funds. Highway expenditures (road maintenance, bridge repair) amounted to $10 billion or 10.7% of state expenditures. Total direct state expenditures from 1970 to 1977 rose 49% from $61 billion to $92 billion.

Figure 15-4 shows that the state government employed 22.3% or 3.5 million public employees in 1977 (3.8% of the employed labor force). Education was the highest state employer, with 1.5 million employees or 42.5% of the total, see Figure 15-7. Health care accounted for 18.2% of state employment with 638,000 employees. Highways employed 7.5% of the total with 261,000 employees. State employment trends from 1950 to 1972 show a 2.0% increase as compared to total employment for all sectors.



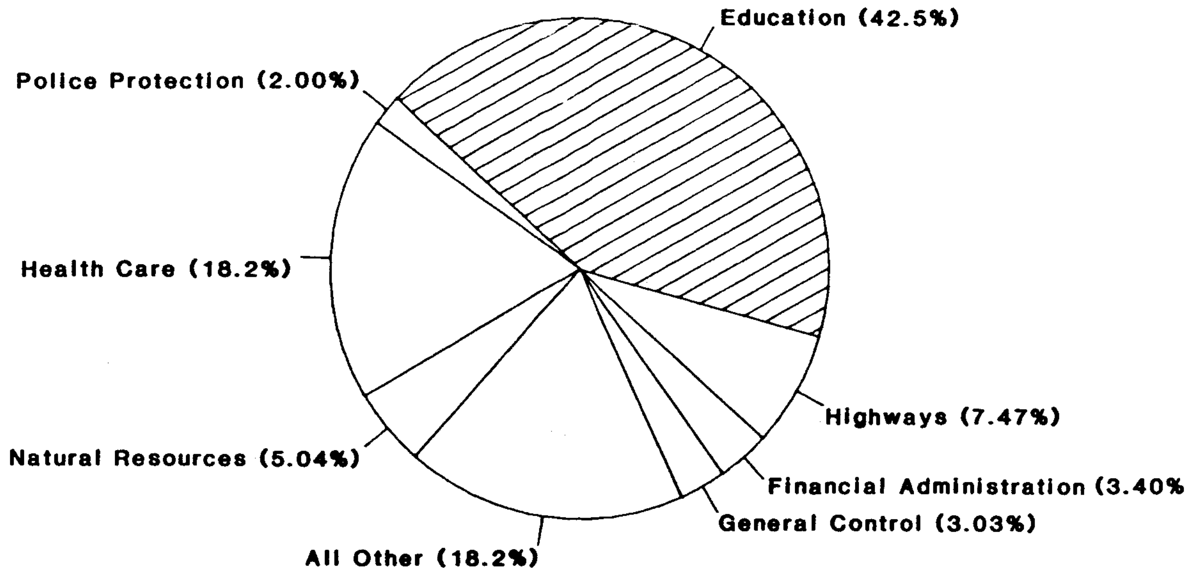
Source: 1977 Census of Governments,
Department of Commerce,
Bureau of the Census

Figure 15-5. Percent of Public Employees (Full & Part Time) by Function, Federal Government



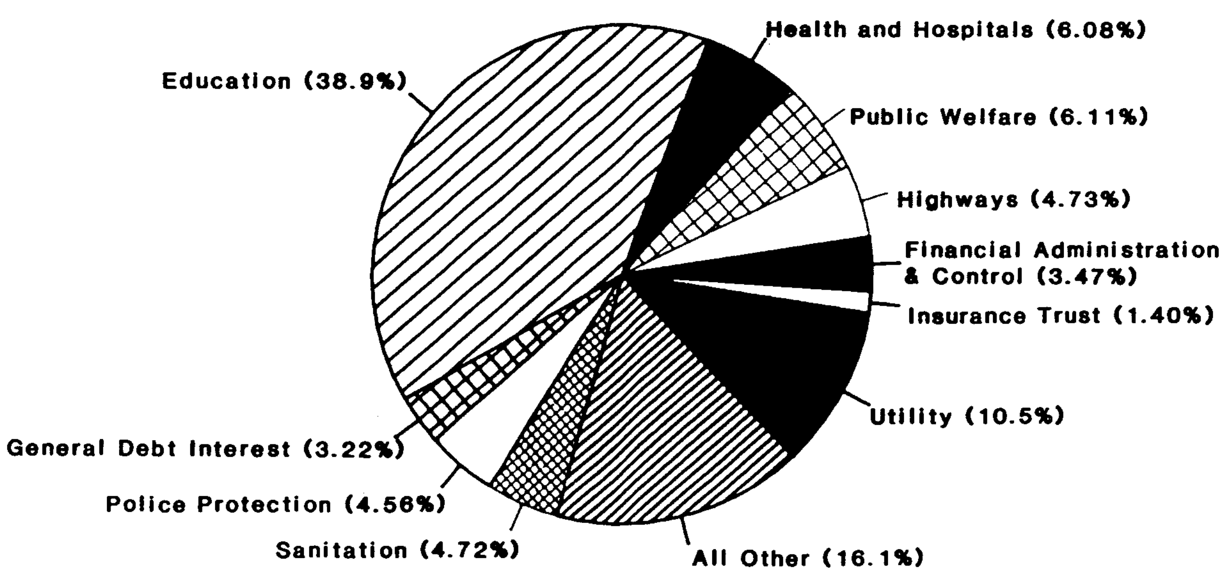
Source: 1977 Census of Governments,
Department of Commerce,
Bureau of the Census.

Figure 15-6. Percent Distribution of Direct Expenditure, by Function, for State Government, 1977



Source: 1977 Census of Governments,
Department of Commerce,
Bureau of the Census.

Figure 15-7. Percent of Public Employees (Full & Part Time) by Function, State Government



Source: 1977 Census of Governments,
Department of Commerce,
Bureau of the Census.

Figure 15-8. Percent Distribution of Direct Expenditure, by Function, for Local Government, 1977

Local Government Enterprises

Figure 15-8 shows that education received $54 billion or 38.9% of direct local government expenditures in 1977 (1972 $), with 94% of these expenditures earmarked for local schools. Utilities (water supplies, electric power, transit and gas supplies) received $15 billion or 10.5% of direct expenditures. Public welfare and health care each received 6.1% of direct expenditures. Total direct local government expenditures rose from $90 billion to $139 billion from 1970 to 1977, a gain of 55%.

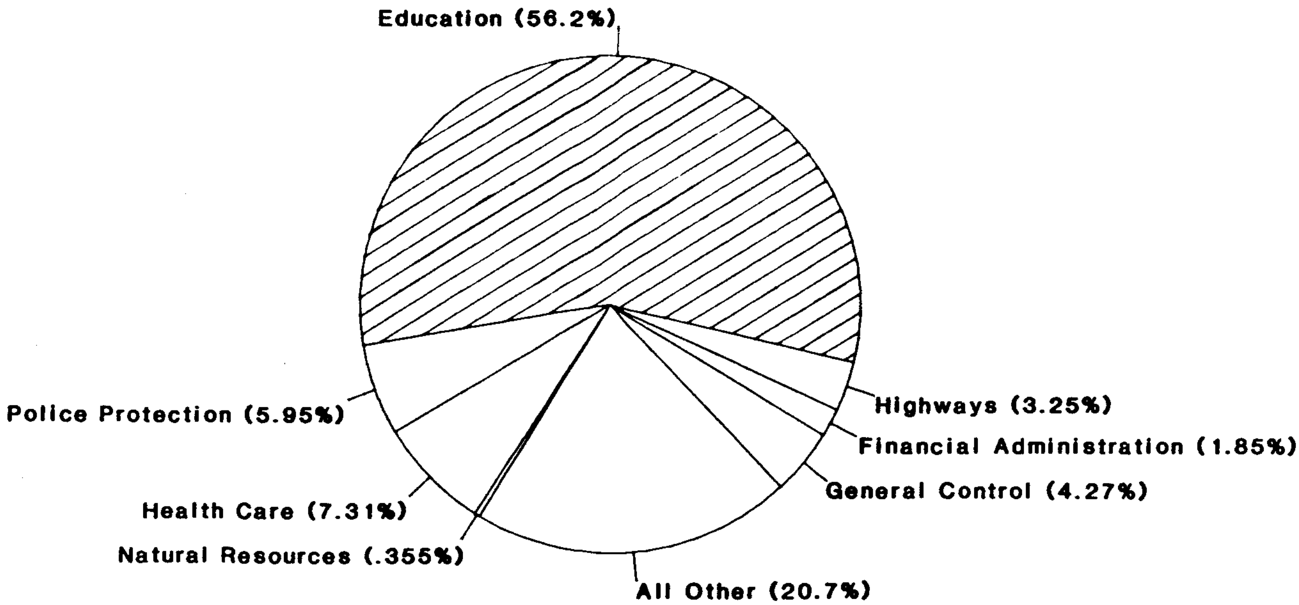
Local government employed 9.3 million or 59.3% of all public employees in 1977. As shown in Figure 15-9, education was the largest local government employer, with 5.2 million employees or 56.2% of the total. Health care employed 678,000 or 7.31% of the total. A 3.9% gain in local government employment has been realized in the 32 year period from 1950 to 1982 when compared to the total employed labor force.

B.15.1 SIGNIFICANT GOVERNMENT EXPENDITURES

Four of the largest government expenditures (for all levels of government combined) were insurance trusts, national defense, health care, and education. Combined they accounted for 57% of all direct government expenditures. They are discussed below:

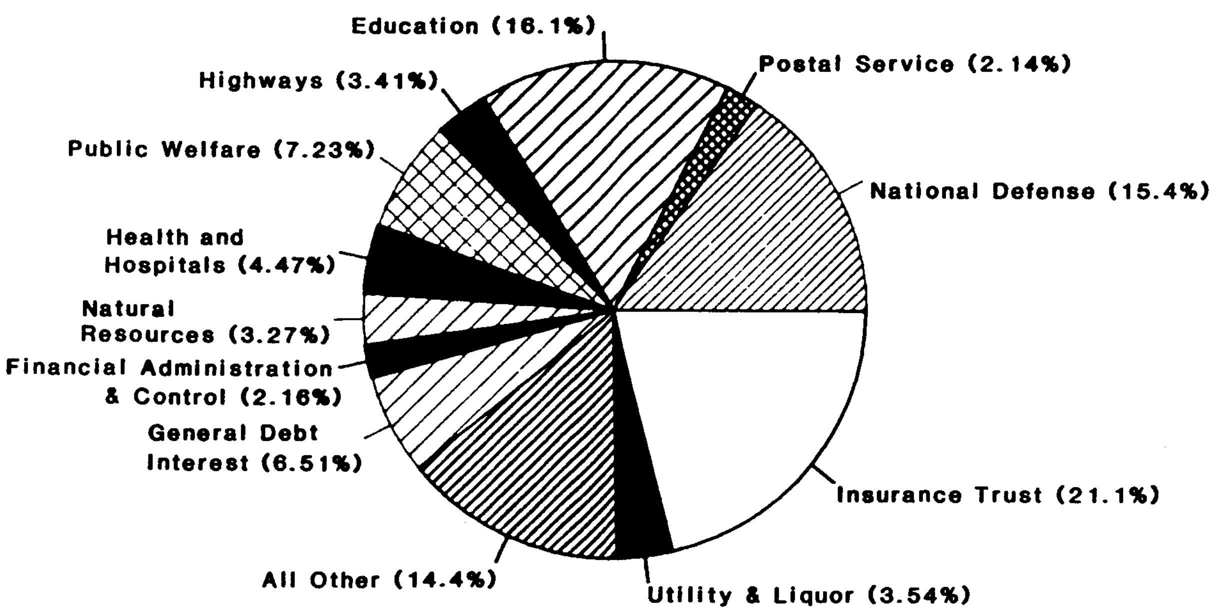
- **Insurance Trusts** received $103 billion, which accounted for 21.1% of all direct government expenditures during 1977 (1972 $), as shown in Figure 15-10. Employee retirement received $13.7 billion, unemployment compensation $10.6 billion, old age, survivors, disability, and health $73.7 billion, and all other insurance $5 billion (all 1972 $).

- **National Defense** (nonmilitary functions only) received $75 billion, which accounted for 15.4% of all direct



Source: 1977 Census of Governments,
Department of Commerce,
Bureau of the Census.

Figure 15-9. Percent of Public Employees (Full & Part Time) by Function, Local Government



Source: 1977 Census of Governments,
Department of Commerce,
Bureau of the Census.

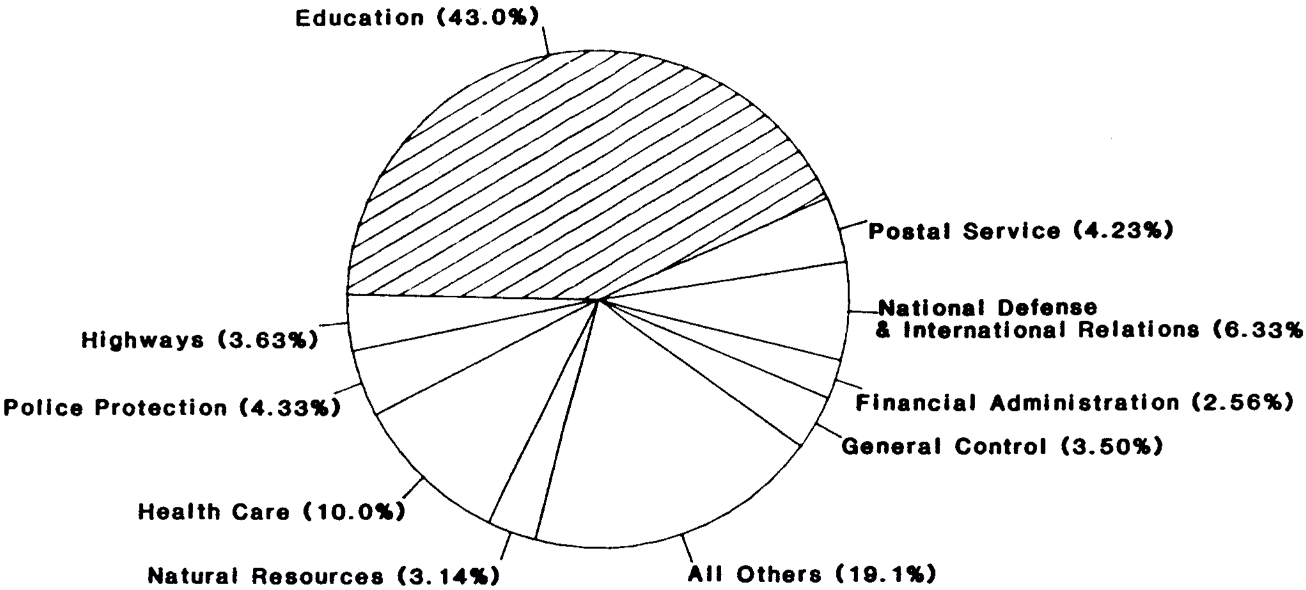
Figure 15-10. Percent Distribution of Direct Expenditure, by Function, For All Governments, In 1977

government expenditures during 1977, in 1972 dollars (Figure 15-10). National defense personnel comprised 6.3% of all public employees (see Figure 15-11).

- **Health Care** received $22 billion, which accounted for 4.5% of all direct government expenditures during 1977 in 1972 dollars (see Figure 15-10). Health costs amounted to $6.6 billion and hospitals costs totaled $15.4 billion. Employment in health and hospital services amounted to 1.6 million people or 10.0% of all public employees. (Figure 15-11). These services are expected to be dramatically influenced by near and long-term technology developments in data management and communications (i.e., artificial intelligence, expert systems, and telepresence) as well as diagnostics, treatment and rehabilitation (sensors, advanced materials, biotechnology, and robotics). Health care is discussed extensively in Section C.1.

- **Education** accounted for 16.1% of all direct government expenditures during 1977 (Figure 15-10). Institutions of higher education received $18.5 billion, local schools $51.1 billion, and all other educational institutions $9.4 billion (in 1972 $).

As shown in Figure 15-11, education accounted for 43% of all public employment in 1977. Education is rapidly changing with the advent of new technology. Technology developments in communications, artificial intelligence, expert systems, and sensors will impact this area. There is likely to be sustained rapid growth in continuing education and training. Because of these factors, Education (SIC 82) has been selected for further analysis of long-term expectations and needs.



Source: 1977 Census of Governments,
Department of Commerce,
Bureau of the Census.

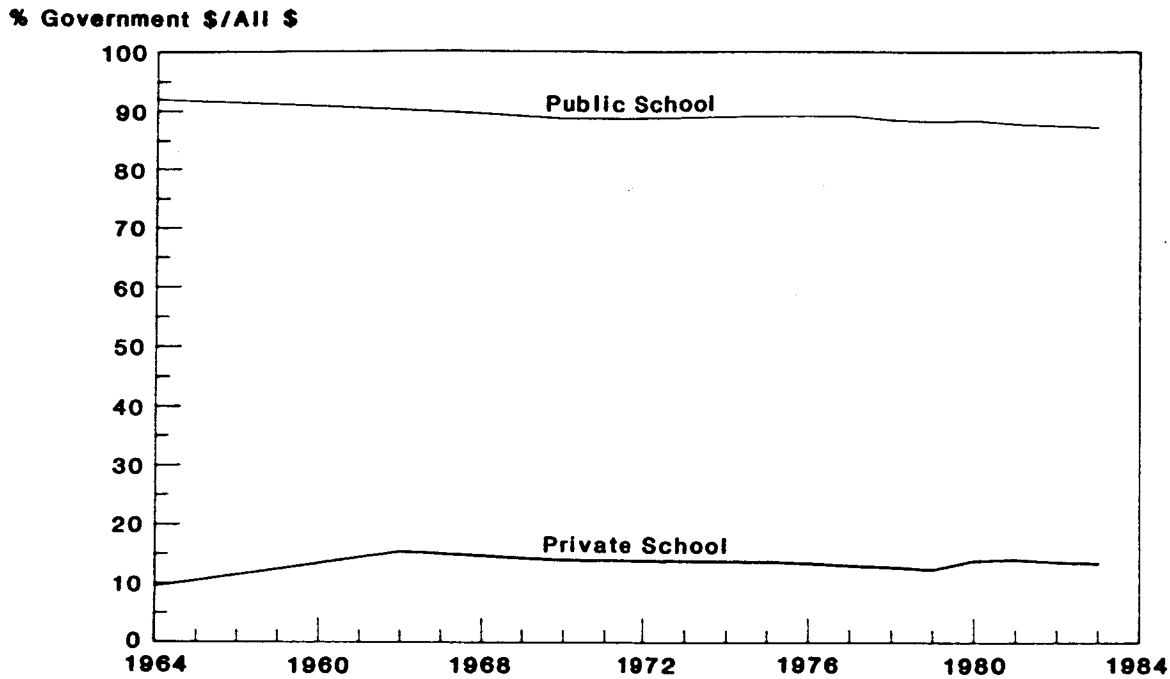
Figure 15-11. Percent of Public Employees (Full & Part Time) by Function, All Government ,1977

B.15.2 EDUCATION

Education (SIC 82) includes those institutions devoted to furnishing formal academic or technical courses. Table 15-2 lists the various educational institutions and the services provided by each.

During 1983, the government spent $71 billion (1972 $) on public education and $3 billion on private. Nongovernment sources contributed $10 billion and $18 billion to public and private education respectively. From 1960 to 1983, government subsidization of public education dropped from 92.0% to 87.3%. During the same period, government subsidization of private education rose from 9.6% in 1960 to 13.6% in 1983, peaking at 14.2% in 1981 (Figure 15-12). The education subsector's business and structural profiles are summarized in Table 15-3 and 15-4 respectively. Table 15-3 shows that, expressed in constant 1972 dollars, education expenditures (public and private) have increased 18% from $92.6 billion in 1972-73 to $109 billion in 1983-84. Much of this increase can be attributed to the higher cost of fuel and other materials. Teacher salaries have affected costs less signficantly; employment of teachers in the public school system (elementary and secondary) has remained at a constant 2.2 million since 1975, a figure which is not expected to rise appreciably in the near future because of declining pupil enrollment.

Table 15-4 shows that public elementary schools account for 70% of public education facilities, while private elementary schools encompass 64% of all private facilities. Overall student enrollment in elementary and secondary schools has declined from 52.2 million in 1970 to 49.2 million in 1982, a decrease of 5.7%. The largest decrease has been in elementary schools, where enrollment has fallen from 30 million in 1970 to 24.4 million in 1982 (a 12.3% decline). College enrollment, however, has realized a 47% increase from 5.7 million in 1970 to 8.4 million in 1982.



Source: 1984 Statistical Abstract of the United States,
Department of Commerce, Bureau of the Census.

Figure 15-12. Government Funding of Public and Private Schools

TABLE 15-2
CLASSIFICATION OF EDUCATIONAL SERVICES (SIC 82)

SIC CODE	SUBDIVISION DESIGNATION AND TYPICAL SERVICE	NUMBER OF INSTITUTIONS
821	**ELEMENTARY AND SECONDARY SCHOOLS**	102,699
	ACADEMIES, BOARDING SCHOOLS, FINISHING SCHOOLS, JUNIOR AND SENIOR HIGH SCHOOLS, KINDERGARTENS, MILITARY ACADEMIES, PREP SCHOOLS, ELEMENTARY SCHOOLS, SCHOOLS FOR THE RETARDED, SCHOOLS FOR THE PHYSICALLY HANDICAPPED, SECTARIAN SCHOOLS, SEMINARIES, AND VOCATIONAL SCHOOLS.	
823	**LIBRARIES AND INFORMATION CENTERS**	32,387
	DOCUMENTATION CENTERS, CIRCULATING LIBRARIES, LENDING LIBRARIES, LIBRARIES, AND BOOK RENTALS.	
822	**COLLEGES, UNIVERSITIES, PROFESSIONAL SCHOOLS AND JUNIOR COLLEGES**	3,253
	COLLEGES, PROFESSIONAL SCHOOLS, SERVICE ACADEMIES, THEOLOGICAL SEMINARIES, UNIVERSITIES, COMMUNITY COLLEGES, JUNIOR COLLEGES, AND TECHNICAL INSTITUTES.	
824	**CORRESPONDENCE SCHOOLS AND VOCATIONAL SCHOOLS**	6,497
	CORRESPONDENCE SCHOOLS, DATA PROCESSING SCHOOLS, BUSINESS SCHOOLS, COMMERCIAL SCHOOLS, SECRETARIAL SCHOOLS, AVIATION SCHOOLS, BANKING SCHOOLS, COMMERCIAL ART SCHOOL, NURSES SCHOOLS, TRADE SCHOOLS, AND VOCATIONAL SCHOOLS.	
829	**SCHOOLS AND EDUCATIONAL SERVICES, NOT ELSEWHERE CLASSIFIED**	N/A
	ART SCHOOLS, AUTO DRIVING SCHOOLS, BATON INSTRUCTION, BIBLE SCHOOLS, CHARM SCHOOLS, CERAMIC SCHOOLS, CIVIL SERVICE SCHOOLS, DICTION SCHOOLS, DRAMA SCHOOLS, FINISHING SCHOOLS, FLYING INSTRUCTION, HYPNOSIS SCHOOLS, LANGUAGE SCHOOLS, MODELING SCHOOLS, MUSIC SCHOOLS, PERSONAL DEVELOPMENT SCHOOLS, PUBLIC SPEAKING SCHOOLS, READING SCHOOLS, TUTORING SCHOOLS, AND VOCATIONAL COUNSELING SCHOOLS.	

SOURCE: EOP/OMB: STANDARD INDUSTRIAL CLASSIFICATION MANUAL, 1972

TABLE 15-3

BUSINESS PROFILE
OF THE EDUCATIONAL SERVICE (SIC 82)

EXPENDITURES (BILLION $) (ALL 1972$)	1972-73	1977-78	1979-80	1981-82	1983-84
ELEMENTARY AND SECONDARY	57.5	64.9	66.5	64.9	66.8
PUBLIC	51.5	58.0	60.0	57.6	59.1
PRIVATE	6.0	6.9	7.5	7.3	7.7
HIGHER EDUCATION	35.1	35.3	38.2	37.5	42.2
PUBLIC	23.3	23.8	25.4	25.0	30.0
PRIVATE	11.8	11.5	12.8	12.5	14.2
TOTAL EXPENDITURES	92.6	100.2	104.7	102.4	109.0

PUBLIC SCHOOL EMPLOYMENT (TEACHERS ONLY) (MILLIONS)	1965	1970	1975	1977	1979	1981	1982
ELEMENTARY	0.9	1.1	1.2	1.2	1.2	1.2	1.2
SECONDARY	0.7	0.9	1.0	1.0	1.0	1.0	1.0
TOTAL	1.6	2.0	2.2	2.2	2.2	2.2	2.2

HIGHER EDUCATION FACULTY EMPLOYMENT (THOUSANDS)	ALL INSTITUTIONS	UNIVERSITY	OTHER 4 YR	2 YEAR
PUBLIC	291	91	114	85
PRIVATE	111	33	72	6
TOTAL	402	124	186	91

SOURCE: U.S. DOC/BOC: STATISTICAL ABSTRACT OF THE U.S., 1984

TABLE 15-4

STRUCTURAL PROFILE OF THE EDUCATIONAL SERVICE (SIC 82)

NUMBER OF SCHOOLS (1981)

PUBLIC		PRIVATE	
ELEMENTARY	59,326	ELEMENTARY	13,333
SECONDARY	22,619	SECONDARY	2,219
COMBINED	1,743	PRIVATE COMBINED	3,459
HIGHER EDUCATION (1982)	1,493	PRIVATE HIGHER EDUCATION (1982)	1,787

ENROLLMENT (MILLIONS)

	1965	1970	1975	1978	1981	1982
NURSERY	0.1	0.3	0.6	0.6	0.6	0.7
K-GARTEN	2.4	2.6	2.9	2.5	2.6	2.7
ELEMENTARY	27.6	30.0	27.2	25.3	24.8	24.4
HIGH SCHOOL	11.5	13.5	14.5	14.2	13.5	13.0
COLLEGE	3.8	5.7	7.7	7.4	8.2	8.4
TOTAL	45.5	52.2	52.8	50.0	49.7	49.2

ENROLLMENT BY AGE FOR NURSERY SCHOOL AND ABOVE (MILLIONS)

AGE	1965	1970	1975	1980	1982
3-4	0.9	1.5	2.1	2.3	2.4
5-6	7.0	7.0	6.6	5.9	6.1
7-13	27.4	28.9	26.1	23.8	23.7
14-15	7.0	7.9	8.3	7.3	7.0
16-17	6.0	6.9	7.4	7.1	6.9
18-19	2.9	3.3	3.8	3.8	3.8
20-21	1.4	1.9	2.4	2.5	2.8
22-24	1.0	1.4	1.7	1.9	2.1
25-29	0.7	1.0	1.7	1.7	1.9
30-34	0.3	0.5	0.9	1.1	1.2
TOTAL	54.6	60.3	61.0	57.4	57.9

SOURCES: U.S. DOC/BOC: STATISTICAL ABSTRACT OF THE U.S., 1984

Competitive Issues in Education

Education, particulary public primary and secondary education, has undergone considerable public scrutiny and criticism over the past two years. The federal government lacks a national education strategy; curriculum requirements and funding levels differ from state to state and from school system to school system. In many foreign countries, by contrast, where a national education policy has been adopted, it is possible for a student to transfer from one school to another at any time during a school year and experience little or no change in texts, courses, or curriculum. In these countries, the quality of education is perceived to be relatively uniform. Comparative education statistics for various countries are discussed below; salient results are summarized in Table 15-5.

- **Literacy rates**--According to the World Almanac, Japan, the U.S., and F.R. Germany all have literacy rates of 99%. (U.S. literacy rates, however, have been reported to be as low as 86%).

- **Age limits and years of compulsory education**--The U.S. requires ten years of education; Japan and F.R. Germany mandate nine years. In all three countries, a child must be at least three years old before entering a preprimary school.

- **Pupil-teacher ratio**

  Primary education--In 1979, Japan had the highest pupil-teacher ratio at 25:1. The ratios in the U.S. and F.R. Germany were 21:1 and 20:1, respectively.

  Secondary education--Including general, vocational, and teacher training, Japan had the highest pupil-teacher ratio at 17:1 in 1979. The U.S. and F.R. Germany had ratios of 14:1 and 15:1, respectively.

TABLE 15-5

COMPARATIVE STATISTICS ON NATIONAL EDUCATION SYSTEMS IN THE U.S., JAPAN AND F.R. GERMANY

• **NATIONAL EDUCATION SYSTEM REQUIREMENTS**

COUNTRY	AGE LIMITS	DURATION (YEARS)	YOUNGEST ENTRANCE AGE
U.S.	7-16	10	3
JAPAN	6-15	9	3
F.R. GERMANY	6-15	9	3

• **COMPARATIVE PUPIL/TEACHER RATIOS, 1979[a]**

COUNTRY	1ST LEVEL	2ND LEVEL
U.S.	21	14
JAPAN	25	17
F.R. GERMANY	20	15

• **EDUCATION AT UNIVERSITY LEVEL, 1980**

COUNTRY	NUMBER OF STUDENTS/ 100,000 INHABITANTS
U.S.	5419
JAPAN	2070
F.R. GERMANY	2008

• **NUMBER OF FOREIGN STUDENTS ENROLLED AT UNIVERSITY LEVEL, 1980**

HOST COUNTRY	NUMBER FOREIGN STUDENTS
U.S.	311,880
JAPAN	6,543
F.R. GERMANY	61,841

a INCLUDES GENERAL, VOCATIONAL, AND TEACHER TRAINING

SOURCE: UNESCO: STATISTICAL YEARBOOK, 1983.

- **Post-secondary enrollment**--In 1980, the U.S. had 5419 students per 100,000 inhabitants, enrolled in post-secondary education; F.R. Germany and Japan had 2000 and 2070 students enrolled, respectively.

- **Post-secondary foreign student enrollments**--In 1980, 311,800 foreign students were enrolled in U.S. post-secondary schools, 61,841 foreign students were enrolled in West German schools and 6,543 in Japanese schools.

- **Public expenditure on education as a percentage of GNP-**-In 1980, the U.S. spent 7.0% of its GNP on education, while Japan spent 5.8%; in 1979, F.R. Germany spent 4.7%

Although the above numbers are indicative of each nation's commitment to education, in terms of money and manpower, the approach is subject to three criticisms. First, categories may not be strictly comparable between countries. For example, many more Americans receive post-secondary education than do Germans or Japanese. The curriculum of a German or Japanese secondary school, however, may cover much of what is taught in U.S. post-secondary schools, thereby offsetting the discrepancies in educational attainment. Secondly, there is no indication of the quality of education in each country. Although the U.S. requires a year more of compulsory education than Germany and Japan, the quality may be such that 10 years of learning in the U.S. is equivalent to, or less than 9 years in other countries. In addition, years of compulsory education say little about the average number of years actually spent in school. Finally, the numbers are inconsistent and, may be misleading. Looking again at the years of education required, the numbers do not include school days per year, or hours of school per day, because there is variance within the U.S. on these issues.

Student funding for higher education in the U.S. has been shifting in recent years toward student loans as opposed to outright grants. As shown in Figure 15-13, 42.9% of student aid is through the guaranteed student loan program.

Basic Trends in Education

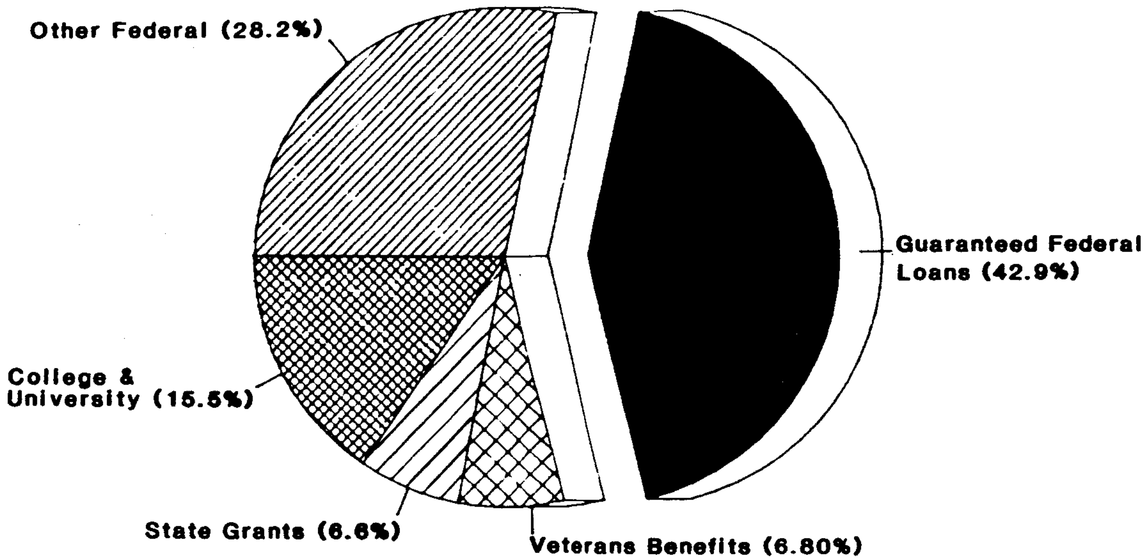
Several demographic, technological, and socioeconomic trends are putting pressure on providers of education to change the structure of the educational system and to increase the quality of education. Among these are:

- **Tendencies toward smaller, later families and the overall aging of the population**--The changing structure associated with a drop in the birth rate has resulted in school closings and consolidations in many regions of the U.S. The decline in the school-age population is expected to persist through 1990, at which point the trend will begin to reverse.

- **Rapid technological developments**--These in turn cause the skills required of the work force to change, creating an increased need for retraining and continued education of workers and professionals at all levels.

- **Lack of prestige and low salaries associated with the teaching profession**--This factor has a negative impact on the quality of incoming teachers and causes many well-qualified potential teachers to seek employment in the higher-paying commercial sector.

- **Aging of the teaching population**--Declining numbers of students have lessened the demand for newly trained teachers. This combined with a low level of continuing-education funds and programs for current teachers serves to downgrade the overall technological preparedness of teachers.



Source: College Board Estimates

Figure 15-13. Sources of Student Aid 1983-1984 Academic Year

- **Public pressure to provide better science and math education.**

- **Increased interest in the use of performance and competency tests.**

- **Increased adoption of computer literacy programs.**

- **Increasing interaction between the business and education communities**--Many business/education partnerships are developing, in which business provides support to local educational systems in many forms including direct grants, curriculum and other planning assistance, teaching assistance, teacher-employee exchange programs and student counseling. But this has also brought about increased demands by business on the education systems to produce graduates more attuned to the skill needs of employers.

New Technologies in Educational Services

Table 15-6 summarizes the technologies currently being developed that are expected to impact the quality of education. They fall into the following two major groupings:

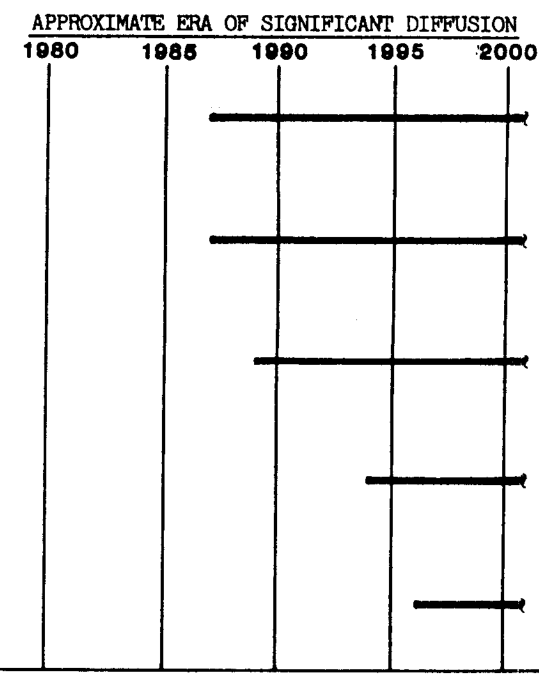
- **More efficient use of educational techniques.** The use of artificial intelligence, education stations and innovative communication techniques would presumably enhance the quality of current educational systems.

- **More widespread application of learning theories.** The use of behavior modification and neurophysiology to increase student receptiveness, recall and cognitive processes.

TABLE 15-6

NEW EDUCATIONAL TECHNOLOGIES

TECHNOLOGY	DESCRIPTION	PRINCIPAL IMPACT	APPROXIMATE ERA OF SIGNIFICANT DIFFUSION 1980 1985 1990 1995 2000
ARTIFICIAL INTELLIGENCE	INTERACTIVE SOFTWARE WHICH RESPONDS TO INDIVIDUAL STUDENTS	INCREASED LEARNING FOR INDIVIDUAL STUDENTS	
EDUCATION STATION, DISPLAYS	INTERACTIVE VIDEODISCS, ANIMATION, MODEL BUILDING	IMPROVE EDUCATION FOR GIFTED AND HANDICAPPED STUDENTS	
COMMUNICATIONS	ABILITY TO RECEIVE AND BROADCAST INEXPENSIVELY	EDUCATION COULD BE DISTRIBUTED ON A BROADER SCALE	
BEHAVIOR MODIFICATION	MAKE STUDENTS MORE RECEPTIVE TO EDUCATION	MORE EFFICIENT USE OF RESOURCES	
NEUROPHYSIOLOGY	INCREASE RECALL AND COGNITIVE FUNCTIONS OF THE BRAIN	INCREASED BRAIN CAPACITY WOULD INCREASE PRODUCTIVITY	



The use of artificial intelligence with interactive software will increase learning for individual students, as will education display stations receiving information from a broadly based education communications network. Behavior modification of students will make students more receptive to education and allow more efficient use of educational resources. The use of neurophysiology to increase recall and cognitive brain functions is also being researched.

Section E.9, Accelerated Learning, further enumerates advanced educational techniques.

Conclusions

The principal strategic issues now facing the educational services in the U.S. relate primarily to retrenchment in the face of declining enrollment, cutbacks in tax revenue and repositioning with a stronger emphasis on the "basics" and measurable student achievement. The educational systems are beginning to become more responsive to technological change and computer literacy programs, while the use of computers is beginning to proliferate. However, this is due largely to impetus from the computer industry itself. The development of effective, interactive software and educational systems has been relatively slow, because the educational services remain highly decentralized and politicized.

The quality and accessibility of U.S. education is highly variable depending on location, and it is anticipated that problems associated with this variability will represent major strategic challenges into the 1990s and beyond. At the primary and secondary levels, over 50% of the funds come from state and local sources, and priorities for their use are established at these levels. Consequently, there is no consistent or centralized effort to adopt or respond to new technologies.

By the year 2000, it is anticipated that the need to adapt to technological change will have to be joined with the need to individualize materials and approaches to different systems, teachers and students. However, those who teach in grades K through 12 have typically received their training in education rather than in specific course areas. According to publishers and suppliers of educational courseware, these teachers are particularly uncomfortable in the scientific areas. Teacher training and retraining is, therefore, also likely to grow in importance during the late 1980s and 1990s as an area for major attention and investment. It is unlikely that educators alone will be able to marshall the resources necessary to take advantage of advances in artificial intelligence or computer and telecommunication technologies. If these and other advanced technologies are to be adapted for use in the school environment, the development of appropriate educational products and the impetus for their use will have to come from outside the schools.

Artificial intelligence applications and improved education stations are likely to represent the most important near-term technology applications to the education industry. Combined with improvements in cost-effective mass storage and communication systems, these technology applications have the potential for substantially improving educational achievement--particularly in areas which currently have the least access to quality teachers and programs. Beyond these applications, the most promising technological breakthroughs are potentially in the area of sensors and neurophysiology, which would permit more individualized interactive systems tailored to learning capabilities and achievement of individual students--particularly the gifted and learning impaired.

B.16 "FINANCE" (SIC 60-61)

TABLE OF CONTENTS

SOURCES: U.S. DOC/BOC:
Statistical Abstract of the U.S., 1984
U.S. DOC/BIE:
1984 U.S. Industrial Outlook
EOP/OMB:
Standard Industrial Classification Manual, 1972
Value-Line Investment Survey, 1984

LIST OF TABLES

B.16 "FINANCE" (SIC 60-61)

The finance industry (SIC 60-61) comprises a major part of the finance, insurance, and real estate subsectors (SIC 60-71) that accounted for 21% of the service sector's contribution to GNP in 1980. (Subsector 62, Security and Commodity Brokers, Dealers, Exchanges, and Services, generally considered a part of the finance industry, will not be discussed in this section.) Table 16-1 outlines the major subdivisions of depository institutions within the two financial subsectors: banking (SIC 60) and credit agencies other than banks (SIC 61). Classified within the two subsectors, but not included in Table 16-1, are the following nondepository institutions: Establishments performing functions closely related to banking such as check cashing agencies (SIC 605), agencies other than banks that are involved with rediscount and financing (SIC 611), agricultural credit institutions (SIC 613) and mortgage brokers (SIC 616). The two largest financial

TABLE 16-1

CLASSIFICATION OF DEPOSITORY INSTITUTIONS WITHIN SIC 60 (BANKING) AND SIC 61 (CREDIT AGENCIES OTHER THAN BANKS)

SIC CODE	SUBDIVISION DESIGNATION	1982 ASSETS (BILLION $)
602	**COMMERCIAL AND STOCK SAVINGS BANKS**	1,878
612	**SAVINGS AND LOAN ASSOCIATIONS**	706
614,615	**PERSONAL CREDIT AND BUSINESS CREDIT INSTITUTIONS**	319
	FEDERAL AND STATE CREDIT UNIONS FINANCE COMPANIES	
601	**FEDERAL RESERVE BANKS**	187
603	**MUTUAL SAVINGS BANKS**	174

SOURCES: U.S. DOC/BOC: STATISTICAL ABSTRACT OF THE U.S., 1984
EOP/OMB: STANDARD INDUSTRIAL CLASSIFICATION MANUAL, 1972

subdivisions as ranked by assets are commercial and stock savings banks (commercial banking, SIC 602) and savings and loan associations (SIC 612). These two subdivisions will be analyzed in this chapter and will be referred to as the finance industry.

Financial institutions in the U.S. are now starting to undergo profound structural changes. These changes have been prompted more by deregulation than by technology. The primary deregulatory action was the Garn-St. Germain Depository Institutions Act of 1982. The salient features are:

- Small savers are provided with higher returns through vehicles such as money market deposit and super NOW (Negotiable Order of Withdrawal) accounts.

- Greater investment authority was given to savings and loan associations and those organizations were allowed to convert to federal savings banks. In the first 7 months of 1983, 98 associations with $43 billion of assets converted to savings banks.

- Regulatory agencies were given greater flexibility to aid financial institutions that are in financial trouble.

- Lending power was enlarged for all depository institutions.

In October 1983, further deregulation occurred when the Depository Institutions Deregulation Committee removed all interest rate ceilings for deposit accounts with a maturity of more than 31 days.

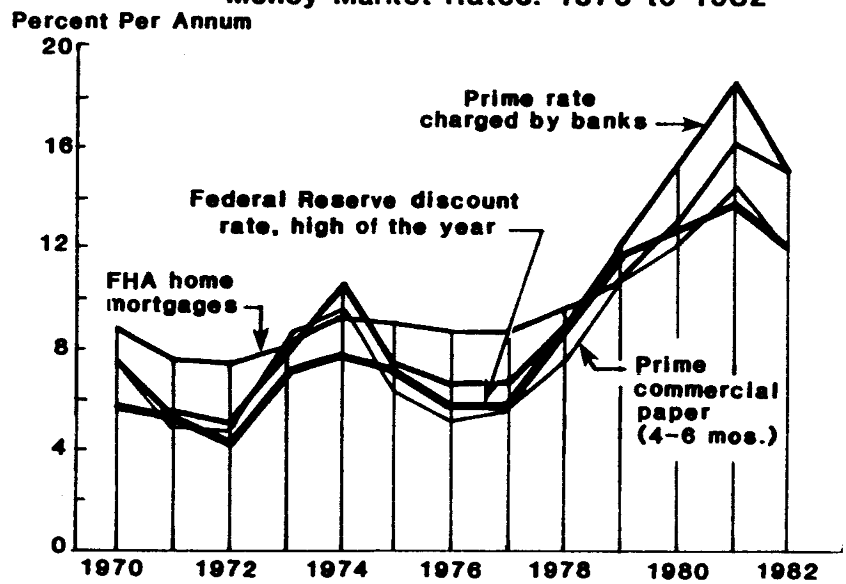
Financial profiles of the commercial banking and savings and loan industry are shown in Tables 16-2,3 and 16-4, respectively. Assets, total employment, the number of banks, and the

TABLE 16-2

BUSINESS PROFILE OF THE
COMMERCIAL BANKING INDUSTRY (SIC 602)

	1972	1977	1979	1981	1983	1984 EST.
ASSETS (BILLION $)						
CURRENT $	739	1,166	1,351	1,652	1,966	2,123
1972 $	739	833	827	847	932	987
TOTAL EMPLOYMENT (THOUSANDS)	1,105	1,238	1,369	1,482	1,530	1,553

Money Market Rates: 1970 to 1982



Source: Chart prepared by the U.S. Bureau of Census

	1978	1982
RETURN ON ASSETS (%)		
ALL BANKS	0.76	0.71
<$100 Million	1.04	1.08
$100 Million to $1 Billion	0.90	0.85
>$1 Billion	0.60	0.56
RETURN ON EQUITY (%)		
ALL BANKS	12.9	12.2
<$100 Million	13.2	12.7
$100 Million to $1 Billion	13.2	12.0
>$1 Billion	12.6	12.1

SOURCES: U.S. DOC/BIE: 1984 U.S. INUSTRIAL OUTLOOK
U.S. DOC/BOC: STATISTICAL ABSTRACT OF THE U.S., 1984
VALUE-LINE INVESTMENT SURVEY, 1984

TABLE 16-3

STRUCTURAL PROFILE OF THE
COMMERCIAL BANKING INDUSTRY (SIC 602)

LARGEST COMMERCIAL BANKS	1983 ASSETS ($ BILLION)
CITICORP	134.7
BANKAMERICA CORP.	121.2
CHASE MANHATTAN CORP.	81.9
MANUFACTURERS HANOVER CORP.	64.3
J.P. MORGAN AND CO.	58.0
CHEMICAL NEW YORK CORP.	51.2

CHANGES IN COMMERCIAL BANKING STRUCTURE

	1970	1977	1979	1981	1982
BANKING OFFICES	37,166	50,695	54,926	59,348	57,913
NUMBER OF BANKS	14,199	15,207	15,201	15,355	15,412
NUMBER OF BRANCHES	22,967	35,488	39,725	43,993	42,501
OFFICES OPENED	1,864	2,524	2,891	2,901	2,387
BANKS	186	206	239	265	379
BRANCHES	1,678	2,318	2,652	2,636	2,008
OFFICES CLOSED	280	483	573	785	3,822
BANKS	165	169	244	240	322
BRANCHES	115	314	329	545	3,500
NET CHANGE DURING YEAR	1,584	2,041	2,318	2,116	-1,435

	1978	1982
NO. OF FDIC PROBLEM BANKS	342	345
NO. OF FAILED BANKS	--	34 (+8 MUTUAL SAVINGS BANKS)

SOURCES: U.S. DOC/BIE: 1984 U.S. INDUSTRIAL OUTLOOK
U.S. DOC/BOC: STATISTICAL ABSTRACT OF THE U.S. 1984
VALUE-LINE INVESTMENT SURVEY, 1984

TABLE 16-4

FINANCIAL PROFILE OF THE
SAVINGS AND LOAN INDUSTRY (SIC 612)

	1972	1977	1979	1981	1983	1984 EST.
ASSETS (BILLION $)						
CURRENT $	236	448	568	651	830	905
1972 $	236	298	348	334	393	421
TOTAL EMPLOYMENT (THOUSANDS)	129	208	242	269	295	313
NET NEW SAVINGS (BILLIONS $)	24	32	15	-25	55	45
NO. OF ASSOCIATIONS	—	—	4,700	4,292	3,513	—

LARGEST PUBLIC SAVINGS AND LOAN ASSOCIATIONS

	1983 ASSETS ($ BILLION)
H.F. AHMANSON AND CO.	20.2
GREAT WESTERM FINANCIAL CORP.	18.6
GOLDEN WEST FINANCIAL CORP.	8.2
IMPERIAL CORP. OF AMERICA	6.1
GIBRALTAR FINANCIAL CORP.	6.0
FINANCIAL CORP. OF SANTA BARBARA	2.5

SOURCES: U.S. DOC/BIE: 1984 U.S. INDUSTRIAL OUTLOOK
VALUE-LINE INVESTMENT SURVEY, 1984

number of branches have been rising slowly between 1982 and 1983 in the commercial banking industry. Increased use of automated teller machines (ATMs) and the high cost of building "brick and mortar" branches (currently $0.25-0.5 million) will probably reduce, or at least stem the increase of the number of branches in the future. Assets and total employment have been increasing at a more rapid rate in the savings and loan industry; assets in 1984 are estimated to be nearly twice the value (constant 1972 $) than they were in 1972, and total employment has more than doubled during the same period. The number of savings and loan associations has been falling: There were 3,500 in 1983 compared with 4,700 in 1979. The return on assets and on equity is higher for smaller banks with less than $100 million in assets than for large banks with $1 billion or more in assets.

The number of problem banks has remained steady, there were 345 problem banks in 1982 (Table 16-3) as compared with 342 in 1978. In 1982, 34 commercial banks and 8 mutual savings banks (SIC 603) failed. Currently, the largest problem bank is Continental Illinois Corp (1983 assets $42.1 billion.)

The net savings flow for the savings and loan industry is shown in Table 16-4. The net new savings is estimated for 1984 at $45 billion, or slightly lower than $55 billion in 1983. The largest (based on assets) commercial banks and savings and loan associations are shown in Tables 16-3 and 16-4 respectively.

Dominant constraints affecting the financial industry are shown in Table 16-5. Although the industry is far less regulated in the past, there are still regulations banning interstate branching and, in 32 states, regulations limiting intrastate branching. There is currently an experiment with regional branching in New England. Since the introduction of money market and Super NOW accounts, the bulk of the money put into these accounts has flowed from passbook checking and certificate accounts already on deposit at financial institutions instead of

TABLE 16-5

DOMINANT CONSTRAINTS AFFECTING THE FINANCIAL INDUSTRY

GOVERNMENT REGULATIONS	ALTHOUGH SUBSTANTIAL DEREGULATION HAS OCCURRED IN INDUSTRY, SOME REGULATION STILL EXISTS: INTERSTATE BANKING PRESENTLY BANNED. IN ADDITION, AT PRESENT 32 STATES ALLOW ONLY LIMITED BRANCHING OR IMPOSE BRANCHING LIMITS.
INCREASED COMPETITION FROM OTHER INDUSTRIES	DEREGULATION HAS CAUSED OTHER INDUSTRIES (i.e., BROKERAGE INDUSTRY) TO OFFER FINANCIAL SERVICES PREVIOUSLY BANNED.
FISCAL/MONETARY POLICY	INDUSTRY INFLUENCED BY INTEREST RATES.

SOURCE: U.S. DOC/BIE: 1984 U.S. INDUSTRIAL OUTLOOK

from money market accounts at competing nondepository firms. Fiscal/monetary policy has a substantial effect on the industry; savings and loan associations are especially affected by high interest rates since most of their loan business is still in residential mortgages with either fixed rates or, or a more recent introduction, adjustable rate mortgages (ARMs) with fixed interest rate ceilings.

Technology in the Finance Industry: An Overview

Leading edge technologies have had only a small impact upon financial businesses which are more social than technological institutions. Consequently, financial business assimilate technology into their operations at a far slower rate than businesses based directly upon the applications of high technology. Thus, the technologies currently used by financial institutions are, on average, five years behind the leading-edge technologies.

This lag in technological usage emanates from the culture of financial businesses, which are slow to adapt to new technology on a personal level, because of the legislatively controlled environment in which they must operate.

As previously indicated, the changes in the finance industry have been prompted more by deregulation than by technology. For example, in the commercial banking industry, the costs associated with the deregulation of products, prices and territorial constraints are only beginning to be felt. The most successful banking organizations in the future will be those capable of delivering products and services at the lowest effective costs. In this respect, bank operations and systems will be of paramount importance. To meet these future competitive demands, bankers will be required to strategically address and plan for the incorporation of the newest technology and various elements of electronic banking in an integrated fashion.

Currently, however, electronic product development and future technological requirements have not been given the priority they must have to permit commercial banks to be low cost producers in the finance industry.

The critical area in this regard is data processing, whose vulnerability in the banking community arises from mismanagement and not from a lack of available technology. At most banks, the focus of data processing management is too narrow. In the absence of either strong senior management direction or heavy marketing influence, expenditures will continue to be made for "add-on-modules," rather than for integrated operating systems. In view of the current deregulation in the finance industry, it is incumbent upon managements to increase productivity through strategic, futuristic electronic banking plans--the centerpiece of which must be a strong data processing capability.

The fragmented approach to electronic banking adopted by many financial institutions has produced such counterproductive results as competing networks and misdirected applications of resources, which have stifled increases in productivity. This narrow emphasis has contributed to accelerated efforts by major retailers to control an increasingly larger portion of the payment system. Retailers have also begun to transform this system from one using bank services to one dominated by retailer systems capable of charging banks for the services provided.

In the last decade, critics of electronic funds transfer have suggested that consumers were not, in fact, interested in electronic banking; indeed, there has never been a ground swell of demand for these services. Nevertheless, as technological improvements are increasingly incorporated into the everyday life of consumers, consumer expectations and demands will rise, perhaps dramatically. In the future, each of these technical developments will give rise to a new series of services. These services will require an expanding base of information which, in turn, must be supported by a corresponding increase in the capacity to deliver data in order to fulfill expanding consumer expectations. These expectations will either overwhelm commercial banks or increase these institutions' profitability, depending upon the extent to which they planned for and incorporated new technology into their operations.

Technology utilization within the finance industry is, in many aspects, more complex than that of other industries. This is because of the heavily regulated business environment, highly personal and confidential nature of the industry services, extremely diverse characteristics and needs of individual customers, huge data bases, interactive nature of the data, accuracy and security requirements, and the time value of information and money.

The dynamic character of the marketplace needs of retail financial services needs little reiteration. The escallating cost of doing business in the future, particularly as it relates to operations and personnel, is expected to steadily impinge on bank profitability. Competition changes almost daily, and regulatory reforms promise even more dramatic developments. The Financial Institutions Deregulation Act, for example, would revise Section C(8) of the Bank Holding Act to permit banking organizations to expand the nature of their insurance and real estate activities.

The rapid pace of change in telecommunications and information technologies, combined with the increased competitive pressures in retail financial services, has produced an accelerating spiral of technological development in commercial banking. In recent years, this technological development has in turn spurred a flurry of activity in the finance industry. The number of service providers of telecommunications and data processing, ranging from hardware vendors to software houses, is too numerous to reference. Even the basic tasks of understanding current electronic fund technology and determining a long-range strategy can be overwhelming to many smaller banking institutions.

The challenges and opportunities involve the basic structures of these organizations. During the next decade, operating systems must be altered and marketing strategies, products and services must be repositioned. The technology of electronic data processing and telecommunications is at the cutting edge of this change. The growing acceptance of various applications of new technologies and the predicted movement toward information-based society can be considered both the cause of the change and the means by which to manage it.

Although electronic funds transfer systems have grown rapidly during the past twelve years, the revolution actually began in the 1950s. At that time the banking industry sought new ways to deal with the increasing volume of checking transactions. In 1954, the first applications of computers were introduced to the business community; the Remington Rand Univac One and the IBM 650 were launched, heralding the arrival of the computer age in commercial banking. By 1956, magnetic ink character recognition (MICR) was chosen by the American Bankers Association (ABA) as the best machine-readable language for check processing. The development of MICR and the electronic data equipment ot process it set the stage for further innovations.

In the 1960s, the larger banks attempted to apply newly found computer capabilities to more effectively handle the swelling volume of paper transactions. This was one of the primary tasks of the California Special Committee on Paperless Entries established in 1968. This committee paved the way for the development of electronically assisted automated clearing houses (EAACHs). Cathode ray tubes (CRTs) for the visual display of digital information were introduced in the 1970s. Viewed in the context of a spiraling evolution, the CRT represented a technological response to market for a broader information handling capacity. Coupled with the alpha-numeric keyboard, the CRT provided a vastly enhanced data entry system, which gradually replaced punched card input. This step toward remote data entry was one of the most significant parts of the evolution and virtually preordained the development of every remote electronic funds transfer (EFT) terminal available today. The CRT/keyboard was initially located in a bank's computer room, attached to a six-foot cable. Today, the same keyboard is on automated teller machines and is part of in-home terminals, representing extended uses of remote data entry. On-line point-of-sale terminals, supermarket electronic cash registers, and new automatic gas pumps are all variaitons of this basic concept of data entry and dissemination.

Table 16-6 gives an abbreviated chronology of the implementation of assorted technologies in the finance industry.

TABLE 16-6

CHRONOLOGY OF TECHNOLOGICAL DEVELOPMENT IN THE FINANCE INDUSTRY

1880-90	HOLLERITH AND POWERS REFINED PUNCH CARD
1920s	ELECTRONIC TELLER MACHINES
1954	UNIVAC I AND IBM 650
1959	MICR STANDARDS RELEASED
1960s	FIRST TRUE COMPUTER APPLICATION IN BANKS
1968	ACH DEVELOPMENT
1970s	CRT/ATM REMOTE ENTRY
1983	ATM SHARING
1983-85	POINT-OF-SALE DEVELOPMENT
1985-90	IN-HOME INFORMATION

The timing of these technological innovations shows that new technologies are being utilized by the banking industry at an exponentially increasing rate. Another factor that becomes evident upon analysis of the data is that the time lapse from the development of the technology to its use in banking is also decreasing at an exponential rate. Extrapolating the data suggests that, by the end of this decade, the banking industry will utilize new technoligies as rapidly as they are developed.

Technologies for the use of financial industry fall into three main categories; 1) hardware, 2) software, and 3) systems. These are all terms that are normally applied to the computer industry. Hardware refers to computers and supporting and peripheral equipment and technologies. Software includes operating systems and programming languages from the lowest to the highest levels. Systems is perhaps the broadest term; it refers not only to specific configurations of hardware and software but also includes any form of interconnection of these configurations. Thus, private branch exchanges (PBX) are a system as well as fiber optics or satellite communications. Videotex and local area networks, in this sense, are other systems.

With the increasing rate of advanced technology utilization by the financial community, it can be safely assumed that any advance in the technology of hardware, software, and systems will produce changes in the operational structure, products, and services of the finance industry. The one element that requires the most improvement in this industry is data base management. Improvements in data base management will, of course, be effected by improvements in hardware, software, and systems. However incremental improvements in these areas do not add linearly to performance; they are synergistic. The effective sum of all improvements is much greater than if each improvement were added apart from the others. Thus, as each technology is reviewed, projections for future performance will generally fall somewhat short of the actual total system performance improvements, since all other technologies are concurrently advancing and being implemented.

Technology and the Future of the Finance Industry

Advances in technology will be only a relatively small driver for improvements in the state of the finance industry in the immediate future. The most pressing current problem is lack of enlightened management. Without changes in management attitudes and better strategic planning, the future of the finance industry is unclear and will involve constant struggles for profitability and market share. If, however, management and organizational structure are improved to the point where they do not impede progress, then predictions can be made concerning future financial services and products.

Most of the progress in the finance industry will be made possible from improvements in data base management; these improvements will result from the use of advanced systems software. Advances in hardware will make these systems improvements somewhat simpler, but currently are not the limiting factor in systems performance in the finance industry. System software improvements will emerge as banks abandon the patchwork systems of the present and replace them with fully integrated systems software packages. These new software packages will be designed from an integrated strategic plan that encompasses all current financial services and those foreseen in the future, such as expanded funds transfer, automated teller machines, and home banking services through videotex. All data bases for all banking departments and functions will become fully interactional through such an integrated data base management system.

Software technology has not advanced nearly as far as hardware technology. Since software is still an emerging technology, especially in the finance industry, the costs, performance levels and management problems involved in implementing functional software continue to be high. Assuming a 4% compounded annual increase in both staff and productivity, there will be about a 30% shortfall between the demand for lines of code and code production. This shortfall will grow to be around 50% by the year 2000 if some new techniques are not developed to increase software production. Some of the techniques that will be forthcoming are described below.

Consolidation will be one such technique. This applies existing tools to software development projects. Many tools have been developed which, although not integrated, can provide immediate improvements. Consolidation will have the most immediate impact upon software productivity; yielding improvements of 25% in productivity and up to 50% in quality. Integrated tool sets evolving from the above will aid and support the software developer. These newer tools will enable him to be more efficient, yield improvements of 50% to 300% in productivity and up to 100% in quality.

Revolutionary new software will be developed that will eventually write lines of code for the bulk of applications; users, rather than the programmers, will be required to determine the design of these software systems. This revolutionary software strategy will use concepts and principles of artificial intelligence and will require more years to take effect, but it could yield improvements of up to 1000% in productivity and two to four times in quality.

Higher level languages will be developed that will increase the functionality that can be expressed in one statement. Training methods and employee training will improve significantly. Rapid prototyping of programs under development will decrease development time and reduce risks prior to full implementation. Automation of the production of documentation will reduce costs and make the user more proficient and efficient.

Substitution of capital for labor is a recurrent theme among institutions committed to improving their electronic banking systems. Automation of back office clerical work associated with telecommunication messages and wire transfers will be one of the ways to accomplish this. Electronic funds transfer (EFT) will become the dominate banking service objective.

EFT is composed of highly sophisticated electronic systems that will handle an individual's personal financial transactions, such as authorizing settlement of monetary obligations, receiving payment for services, eating in restaurants, or shopping in stores. Businesses of all types as well as the government will also be encompassed by the broad applications of EFT. Through EFT techniques, corporate treasurers will be able to freely move funds more cost effectively to where they may be needed at any given time, or to temporary short term interest generating accounts. Companies will initiate payment for goods and services as a by-product or daily business activities.

Within the banks, the costs of tellers is raising; whenever possible they will be replaced by automated teller machines. The latter have 24-hour availability and, in theory, do not make mistakes. At the same time banks are facing increasing competition from brokerage houses and the savings and loan industry in such areas as cash management accounts. Commercial banks will attempt to become more competitive by using the electronic route to the fullest extent possible. A significant developing trend is the provision of more convenience for automated teller machine customers through shared networks. Some of the benefits shared automated teller machine networks are:

- The ability for regional and community banks to offer services they could not otherwise affort and, thus, compete with larger banks;

- The competitive advantage of a large base of credit and debit cards over specialized, regional cards;

- The possibility of turning a profit from processing electronic transactions.

These shared services will be made possible by a national system of networks to which banks and other financial institutions will subscribe. Although there are elements of national networks in place now, the future networks will be much faster and more cost effective through the use of satellite communications. The capacity of such satellite systems would be such that only two competing networks will be required to serve the entire nation.

For the individual, there will be two major changes in financial services that will be most apparent and have the greatest impact on his everyday life style. Both will develop toward the end of the 1980s. They are home banking and debit cards.

Home banking will grow as the use of personal computers grows from 10 million in 1984 to 60 million in 1990. Computers will not be bought exclusively for home banking. Proliferation of other nonfinancial services, such as videotex with the North American Presentation-Level Protocol Standard, will be the major attraction. Home banking will be only one of the services available through this system. However, the use of home banking will reduce banking costs from $1.20 for a teller transaction to less than $0.10 per electronic transactions in high volume.

The debit card will form the basis of comprehensive customer/institution relationships, serving as the key mechanism for both financial transactions and other personal conveniences. After 1990, the debit card will contain a solid state memory and microprocessor. In short, the debit card will become a device for accomplishing multiple functions. As bank communications networks become multiple application communication systems, the combination of these developments will produce profound changes in our society, particularly as it relates to the payment mechanism.

Conclusion

The finance industry is currently on the threshhold of major technological advances. The biggest change, from the banker's standpoint, will be in data base mangement, the consumer, on the other hand, will see increased use of automated teller machines and the advent of home banking. The finance industry is dependent upon advances in the computer software industry, and the difusion of computer hardware for home banking to become common place.

Government-mandated deregulation has already made substantial impact on the finance industry, but further deregulation will occur causing increased blurring of the difference between, various types of financial institutions.

B.17 "TRANSPORTATION SERVICES" (SICs 41, 42, 44 through 47)

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

B.17 "TRANSPORTATION SERVICES" (SICs 41, 42, 44 THROUGH 47)

B.17.1 OVERVIEW OF THE TRANSPORTATION INDUSTRY

Total U.S. outlays for all forms of transportation amounted to $595.1 billion in current dollars in 1981, equivalent to 31.4% of the U.S. GDP. This expenditure includes both the acquisition and the operation of transportation means from all sources: private, federal, state and local governments. As shown in Figure 17-1, the major contributor to the outlay (52%) is private passenger transportation, 97% of which is attributable to the acquisition and use of personal automobiles, 3% to the acquisition and use of private aircraft. Of the total outlay of $595.1 billion, public expenditures (federal, state, and local for airports, airways, highways, R&D programs, Urban Mass Transportation) amounted to $23.4 billion or 3.9%. Of these public expenditures, 73% were in support of ground transportation, 16% for air, and 10% for water transportation.

Figure 17-1 shows that total outlays for passenger transportation represent 61% of the U.S. transportation total; whereas, outlays for the transportation of goods represent 39%.

The portion of U.S. transportation activities related to private use, listed by the Bureau of the Census as SIC code 37, is described in Section B.2, "Transportation Equipment." SIC subsectors 41, 42, 44 through 47, "Transportation Services," representing activities which are for hire, are covered in this Section.

B.17.2 THE TRANSPORTATION SERVICES INDUSTRIES

The transportation services industry includes establishments which provide passenger transportation, primarily to the general public; and freight transportation, primarily to business enterprises. The activities of the industry's major subsectors are

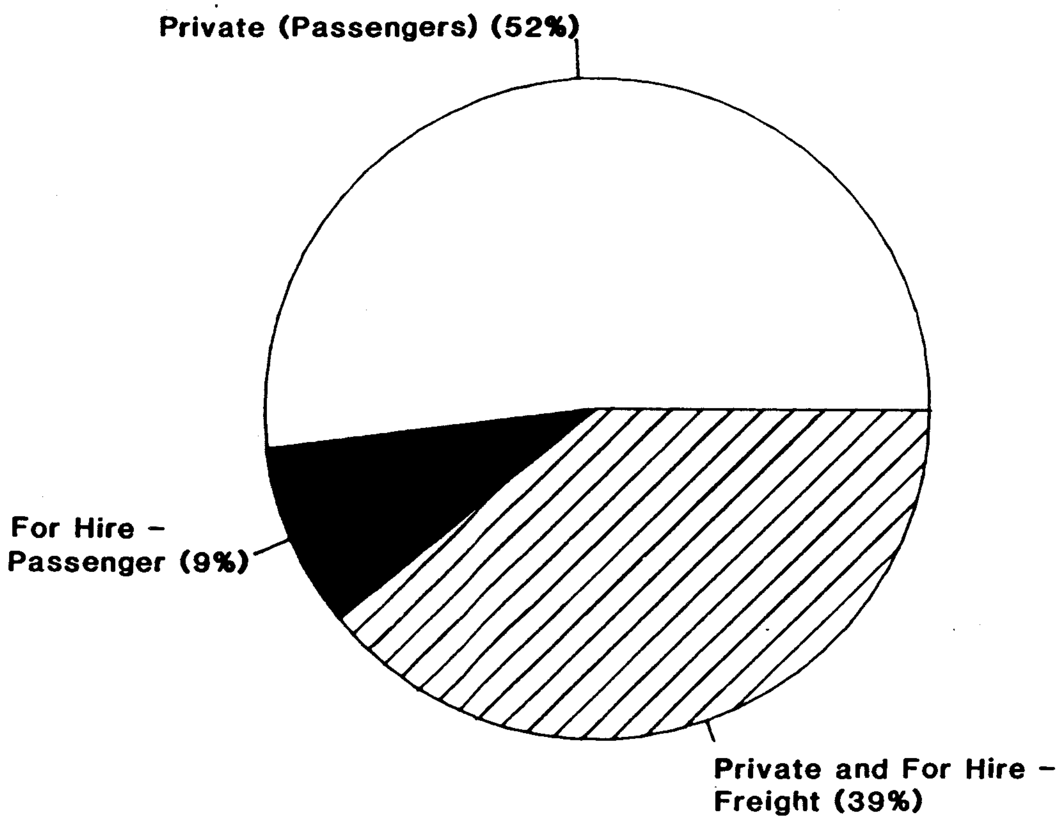


Figure 17-1. Percentage of Passenger & Freight Transportation Outlays by Type of Transport

outlined in Table 17-1. Note that in terms of economic value, intercity transportation is significantly more important than local (intracity) carriage.

Figure 17-2 illustrates the distribution of domestic intercity freight traffic by mode of transport. Railroads move the highest percentage of freight ton-miles among all other transportation modes. Figure 17-3 indicates that significant changes have occurred in passenger transportation since 1950. Railroad passenger traffic has steadily declined in favor of airlines, which now exceed all other modes of mass passenger transport. In 1983, air passenger-miles represented 86% of all for-hire passenger travel.

Figure 17-4 shows the relative distribution of freight carried versus revenue earned for the four modes of transportation. The ratio, i.e., dollars per ton-mile, is an indicator of the "value" of the transported merchandise. It can be seen that railroads accounted for approximately 36% of all freight ton-miles but only 28.2% of all operating revenues. The average freight revenue per ton-mile for railroads in 1979 was $0.026. Air carriers only accounted for 0.3% of all ton-miles, but averaged $0.41 per ton-mile. Oil pipelines accounted for 23.6% of all ton-miles, averaging $0.0094 per ton-mile. Water transportation accounted for almost 17% of all ton-miles, averaging $0.0090 per ton-mile. Motor carriers freighted the same percentage of ton-miles as oil pipelines, but trucking revenue per ton-mile averaged $0.127. Thus, air and motor carriers transport higher value merchandise, as measured in revenue per ton-mile then waterways, oil pipelines and railroads. The differences in transportation costs reflect differences in flexibility and speed. Motor carriers, air carriers, and railroads are much more flexible modes of transportation since they are able to link a large number of points with direct line-haul service. Air and motor carriers offer the two fastest modes of transportation. Waterways freight is the slowest, with typical line-haul speeds between 3 to 7 miles per hour.

TABLE 17-1

CLASSIFICATION OF MAJOR SERVICES
OF THE TRANSPORTATION SERVICE GROUP
AND CONTRIBUTION TO TRANSPORTATION OUTLAY

SIC CODE	SUBDIVISION AND TYPICAL SERVICE	% CONTRIBUTION
40	**RAILROAD TRANSPORTATION**	11%
401	**RAILROADS**	
	TRANSPORTATION OF BOTH GOODS AND PASSENGERS.	
402	**RAILWAY EXPRESS**	
	RAILWAY EXPRESS TRANSPORTATION.	
41	**LOCAL AND SUBURBAN TRANSIT AND INTERURBAN HIGHWAY PASSENGER TRANSPORTATION**	8%
411	**LOCAL AND SUBURBAN TRANSIT**	
	LOCAL BUS, RAILWAY, STREETCAR, SUBWAY, TROLLEY, AERIAL TRAMWAYS, AMBULANCE AND SIGHTSEEING BUS SERVICE AS WELL AS RENTAL OF AUTO, HEARSE, AND LIMOUSINE RENTAL WITH DRIVERS AND AMBULANCE SERVICE.	
412	**TAXICABS**	
	PASSENGER TRANSPORTATION BY AUTO NOT OPERATED ON REGULAR SCHEDULES OR BETWEEN FIXED TERMINALS.	
413	**INTERCITY & RURAL HIGHWAY PASSENGER TRANSPORTATION**	
	INTERCITY, INTERSTATE & INTERURBAN BUS LINES.	
414	**PASSENGER TRANSPORTATION CHARTER SERVICE**	
	LOCAL & LONG DISTANCE BUS CHARTER SERVICE.	
415	**SCHOOL BUSES**	
	TRANSPORTATION OF PUPILS TO AND FROM SCHOOL.	
417	**TERMINAL AND SERVICE FACILITIES FOR MOTORVEHICLE PASSENGER TRANSPORTATION**	
	BUS TERMINAL OPERATION AND MAINTENANCE FACILITIES FOR MOTOR VEHICLE PASSENGER TRANSPORTATION.	
42	**MOTOR FREIGHT TRANSPORTATION AND WAREHOUSING**	60%
421	**TRUCKING, LOCAL, AND LONG DISTANCE**	
	SHIPMENT OF GOODS WITH OR WITHOUT STORAGE. INCLUDES: COMMODITIES, REFUSE, BAGGAGE, FURNITURE, AND PARCEL DELIVERY.	
422	**PUBLIC WAREHOUSING**	
	STORAGE OF FARM PRODUCTS, REFRIGERATED GOODS, HOUSEHOLD GOODS, AUTOS, FURS, LUMBER, OIL & PETROLEUM CHEMICALS AND LIQUOR.	

TABLE 17-1 (CONTINUED)

CLASSIFICATION OF MAJOR SERVICES
OF THE TRANSPORTATION SERVICE GROUP
AND CONTRIBUTION TO TRANSPORTATION OUTLAY

SIC CODE	SUBDIVISION AND TYPICAL SERVICE	% CONTRIBUTION
423	**TERMINAL AND JOINT TERMINAL MAINTENANCE FACILITIES FOR MOTOR FREIGHT TRANSPORTATION**	
	FREIGHT TRUCKING TERMINALS, WITH OR WITHOUT MAINTENANCE FACILITIES.	
44	**WATER TRANSPORTATION**	5%
441	**DEEP SEA FOREIGN TRANSPORTATION**	
	FREIGHT OR PASSENGER TRANSPORTED ON DEEP SEAS BETWEEN U.S. AND FOREIGN PORTS.	
442	**DEEP SEA DOMESTIC TRANSPORTATION**	
	FREIGHT OR PASSENGER TRANSPORTATION ON DEEP SEAS TO AND BETWEEN NONCONTIGUOUS TERRITORIES, COASTWISE PORTS AND INTERCOASTAL PORTS.	
443	**GREAT LAKES - ST. LAWRENCE SEAWAY TRANSPORTATION**	
	TRANSPORTATION OF FREIGHT AND PASSENGER ON GREAT LAKES/ST. LAWRENCE SEAWAY BETWEEN U.S. AND CANADIAN PORTS.	
444	**TRANSPORTATION ON RIVERS AND CANALS**	
	TRANSPORTATION OF FREIGHT AND PASSENGERS ON ALL INLAND WATERWAYS INCLUDING INTRACOASTAL WATERWAYS.	
445	**LOCAL WATER TRANSPORTATION**	
	TRANSPORTATION OF GOODS AND PASSENGERS VIA FERRIES AND LIGHTERAGE. ALSO INCLUDES TOWING AND TUGBOAT SERVICE, AIRBOATS, EXCURSION BOATS, SIGHTSEEING BOATS AND WATER TAXIS.	
446	**SERVICES INCIDENTAL TO WATER TRANSPORTATION**	
	MARINE CARGO HANDLING, CANAL OPERATION, BOAT HIRING, MARINAS, SHIP CLEANING, AND OIL SPILL CLEAN UP.	
45	**TRANSPORTATION BY AIR**	11%
451	**AIR TRANSPORTATION, CERTIFICATED CARRIERS**	
	COMPANIES ENGAGED IN THE TRANSPORTATION OF REVENUE PASSENGERS OR IN THE TRANSPORTATION OF CARGO AND FREIGHT.	
452	**AIR TRANSPORTATION, NONCERTIFICATED CARRIERS**	
	NONCERTIFICATED CARRIERS WHICH CARRY PASSENGERS, FREIGHT AND CARGO.	

TABLE 17-1 (CONTINUED)

CLASSIFICATION OF MAJOR SERVICES
OF THE TRANSPORTATION SERVICE GROUP
AND CONTRIBUTION TO TRANSPORTATION OUTLAY

SIC CODE	SUBDIVISION AND TYPICAL SERVICE	% CONTRIBUTION
458	**FIXED FACILITIES AND SERVICES RELATED TO AIR TRANSPORTATION**	
	INCLUDES AIRPORTS, FLYING FIELDS AND AIRPORT TERMINAL SERVICES.	
46	**PIPELINES, EXCEPT NATURAL GAS**	5%
461	**PIPELINES, EXCEPT NATURAL GAS**	
	CRUDE AND REFINE PETROLEUM PIPELINES, COAL PIPELINES, AND SLURRY PIPELINE (NATURAL GAS IS SIC 4922).	
47	**TRANSPORTATION SERVICES**	5%
471	**FREIGHT FORWARDING**	
	INCLUDES CUSTOMS CLEARANCE OF FREIGHT, DOMESTIC FORWARDING, FOREIGN FORWARDING, FREIGHT CONSOLIDATION, FREIGHT FORWARD, AND SHIPPING DOCUMENTS PREPARATION.	
472	**ARRANGEMENT OF TRANSPORTATION**	
	AIRLINE, BUS, RAILROAD, AND STEAMSHIP TICKET OFFICES, ARRANGEMENT AND TOURIST AND TRAVEL AGENCIES FOR THE ARRANGEMENT TRANSPORTATION OF PASSENGERS; OF FREIGHT AND CARGO TRANSPORTATION.	
474	**RENTAL OF RAILROAD CARS**	
	RENTAL OF RAILROAD CARS WITH OR WITHOUT CARE OF LOADING.	
478	**MISCELLANEOUS SERVICES INCIDENTIAL TO TRANSPORTATION**	
	INSPECTION AND WEIGHING SERVICES; PACKING AND CRATING; TOLL BRIDGE, TOLL ROADS, AND TUNNEL OPERATIONS.	

SOURCES: EOP/OMB: STANDARD INDUSTRIAL CLASSIFICATION MANUAL, 1972
U.S. DOC/BOC: STATISTICAL ABSTRACT OF THE U.S., 1984

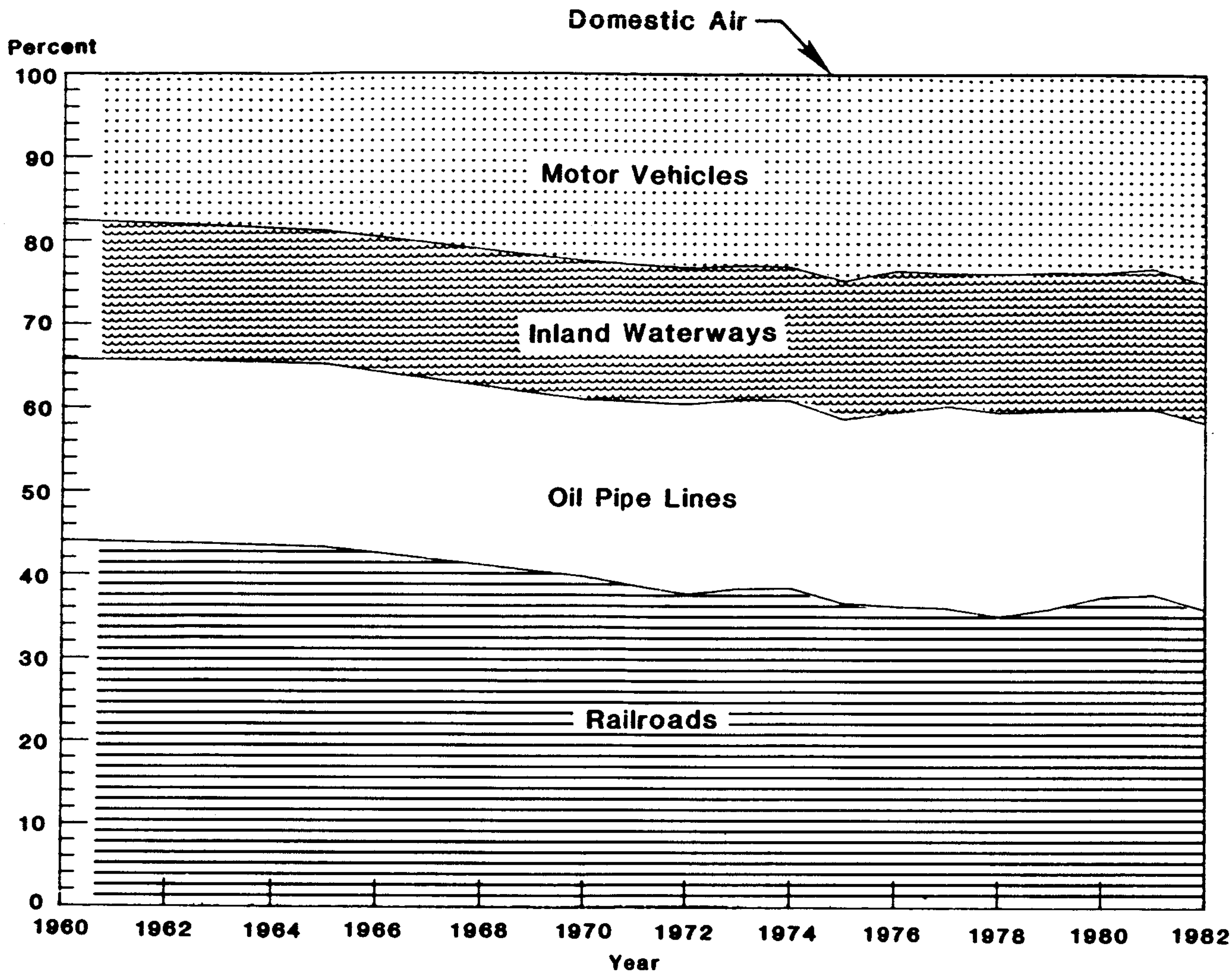


Figure 17-2. Ton-Miles/Domestic For Hire Intercity Freight Traffic - Percent Distribution by Mode

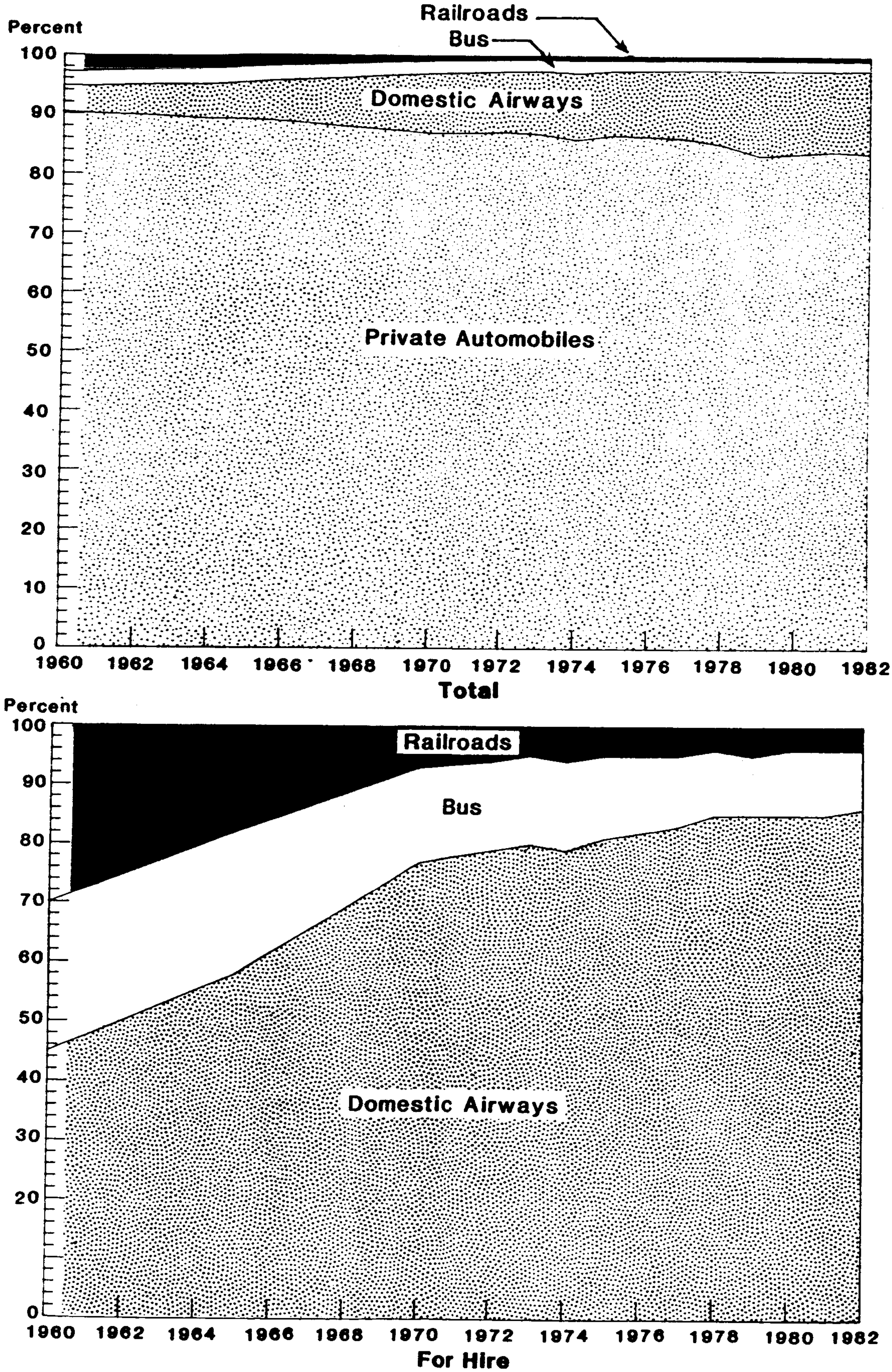


Figure 17-3. Passenger-Miles/Domestic Intercity Passenger Traffic Percent Distribution by Mode

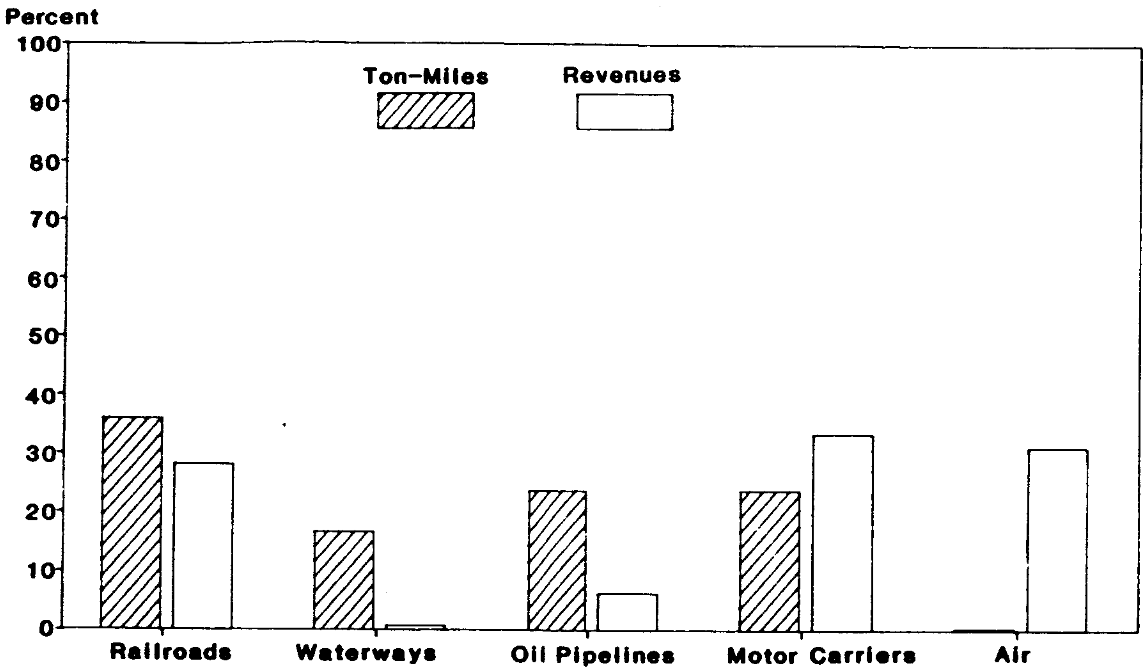


Figure 17-4. Relative Distribution Of Freight Ton-Miles Versus Operating Revenues For 1979

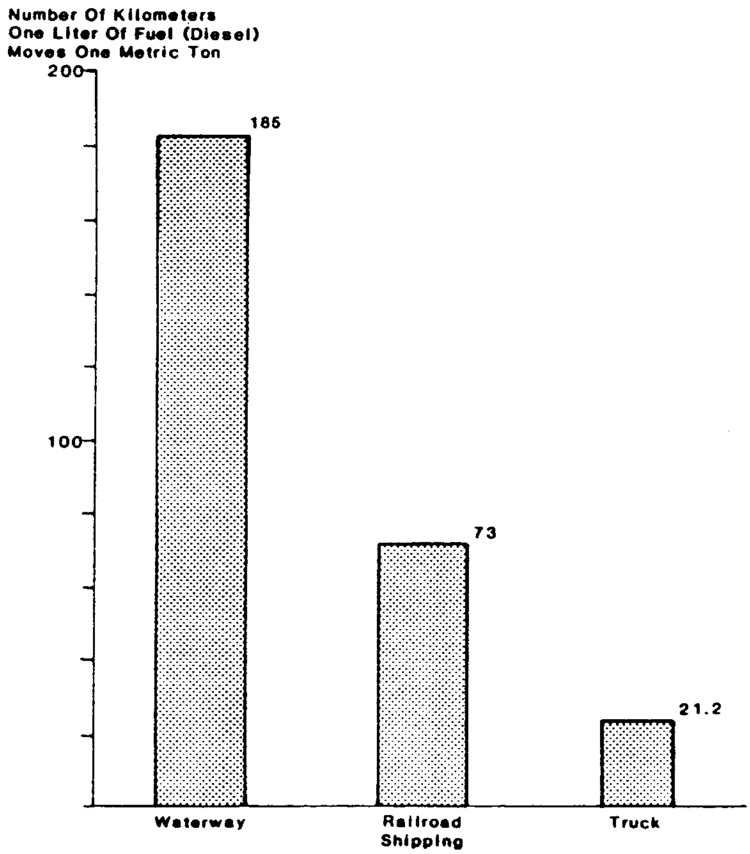


Figure 17-5. Fuel Efficiency For Three Transportation Modes

Fuel consumption is another important consideration. Figure 17-5 shows the average relative fuel efficiency of truck, railroad, and water modes of transportation in the U.S. Water transportation is clearly superior to other modes with regard to fuel efficiency.

Major factors which shippers consider in choosing a transportation mode include characteristics of the commodity to be transported, length of haul, value per ton, materials handling methods, time sensitivity, vehicle capacity, and total annual point-to-point tonnage. Generally, the lower the value of a commodity, the less the time sensitivity involved; the greater the amount of tonnage to be moved, the greater the advantage of waterway barges as the most efficient form of transportation.

The structure and distribution of the transportation service industry in foreign countries varies significantly from U.S. domestic conditions. Tables 17-2 and 17-3, as well as Figure 17-6, compare the U.S. distribution of passenger and freight services with those of Japan and Italy.

Regarding passenger transportation, Japan and Italy transport more passengers via railroads than the U.S. Figure 17-6 indicates that in the U.S. more than 83% of all passenger miles traveled is by private automobiles. In Japan travel by private auto exceeds travel by railroad by only 1%. Travel by air is far more popular in the U.S. than in Japan or Italy. Air transportation is the second highest mode of passenger transportation in the U.S., exceeded only by private autos. Although passenger travel via railroads in the U.S. accounts for less than 1% of the total passenger traffic, railroads accounted for more than 47% of freight traffic. Air freight transportation is negligible in the U.S., Japan and Italy. Nearly 50% of all freight in Japan is transported via water. The differences in transportation among countries are due to such factors as geographic location, size of the country, terrain, and population density.

TABLE 17-2

PASSENGER KILOMETERS PER CAPITA BY TYPE OF TRANSPORTATION 1981

	RAILROAD	BUS	PRIVATE AUTOMOBILE	DOMESTIC AIR
U.S.	47.8	117.5	5855.4	992.59
JAPAN	2702.5	929.2	2805.9	264.59
ITALY	803.57	N/A	N/A	42.85

SOURCES: U.S. DOC/BOC: STATISTICAL ABSTRACT OF THE U.S., 1984
OFFICE OF THE PRIME MINISTER, JAPANESE STATISTICAL YEARBOOK
ANNUARIO STATISTICO ITALIANO

TABLE 17-3

PERCENT DISTRIBUTION OF FREIGHT TRAFFIC BY MODE FOR THE U.S. AND JAPAN 1981[a]

	RAILROADS	TRUCKS	AIR	WATER
U.S.	47.9	29.6	0.28	22.1
JAPAN	7.9	42.4	0.07	49.5

[a] EXCLUDES OIL PIPELINE TRANSPORTATION

SOURCES: U.S. DOC/BOC: STATISTICAL ABSTRACT OF THE U.S., 1984
OFFICE OF THE PRIME MINISTER, JAPANESE STATISTICAL YEARBOOK
ANNUARIO STATISTICO ITALIANO

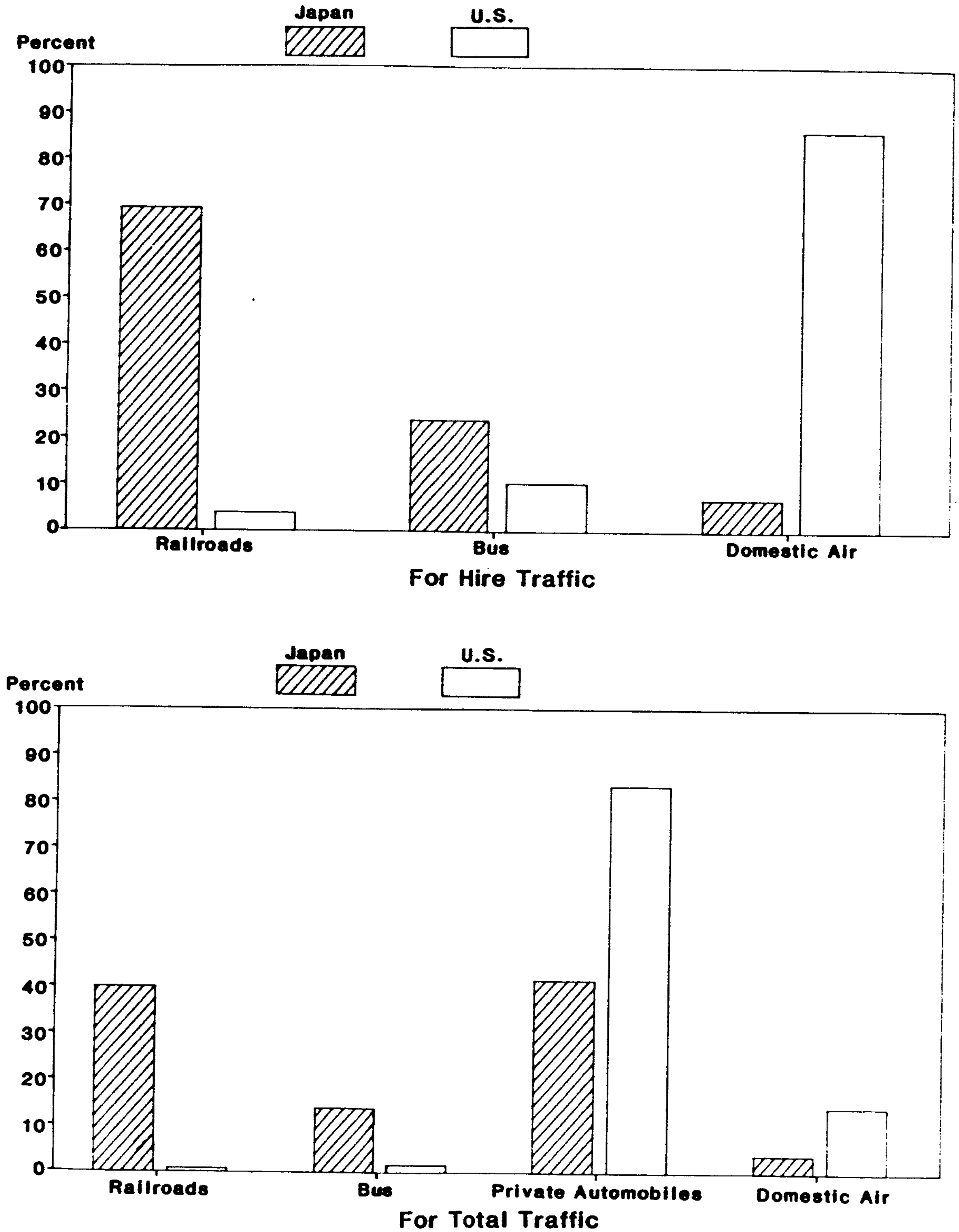


Figure 17-6. Percent Distribution of Passenger Traffic by Mode for the U.S. and Japan (1981)

Four of the SIC groups associated with transportation services have been selected for detailed analysis in order to assess long-term technology needs:

- Railroad Transportation (SIC 4011)--intercity freight
- Trucking (SIC 421)--intercity freight
- Air Transportation (SIC 451)--intercity passengers
- Water Transportation (SIC 44)--intercity freight

Intercity transportation is considered because it is the most economically significant. Portions of intracity transportation data are of less certain reliability, because these types of transportation are not regulated by the Interstate Commerce Commission.

Railroad transportation accounted for 11% of total for-hire transportation outlays in the U.S. in 1981. Railroads also accounted for 36% of all freight traffic in 1982. Trucking accounted for 22% of all freight traffic in 1982. The rail and trucking transportation industries are beginning joint transportation ventures which will utilize both modes of transportation and result in increases in both flexibility and time. Because of the rising number of these joint ventures, new technological innovations are emerging within the two industries.

Domestic air transportation accounted for 86% of all for-hire passenger traffic in 1981. In response to the increases in passengers, a large number of new technologies are now entering the air transportation industry in order to alleviate delays, facilitate passenger movement through terminals, increase seating capacity, lower fuel consumption, etc.

Water transportation is the least expensive mode of freight transportation, accounting for 16% of all freight traffic, 5% of the total for-hire transportation outlays, and approximately 7% of all federal outlays for transportation.

B.17.3 RAILROAD TRANSPORTATION (SIC 40)

Whereas railroad transportation accounted for 36% of all the ton-miles transported in 1982, the railroad industry revenues are lower than the revenues of the other transportation industries (i.e., airlines, trucking). This is because railroad revenues are derived from lower value bulk commodities, such as coal, farm products and chemicals. Railroads accounted for only 4.3% of total revenue passenger-miles in 1982.

The freight railroad industry suffered during the economic recession of 1982. By mid 1983 the industry was experiencing a slow but steady upswing in traffic. However, while earnings showed signs of improvement, the industry continued to lag behind the U.S. economic recovery.

The historical business profile of the intercity railroad industry, summarized in Table 17-4, indicates that revenues and capital expenditures remained at 1972 levels in 1982 when measured in constant 1972 dollars. Table 17-4 also indicates that revenue ton-miles remained at the same 1972 level, and that the rate-of-return on net investment declined slightly, from 2.34% in 1972 to 2.11 in 1982 (in 1929, by contrast, it was 5.20%).

The business profile indicates that the railroad transportation industry is highly labor-intensive. Although computer applications are utilized by the railroads, the majority of rail operations are carried out by railroad employees. Labor costs account for approximately 55% of all railroad operating revenues. Maintenance of Way and Equipment Payroll accounts for 35% of the total payroll.

TABLE 17-4

BUSINESS PROFILE OF THE
FREIGHT RAILROAD INDUSTRY (SIC 401)

	1972	1977	1979	1981	1982	1983	1984 EST.
REVENUES (BILLION $)							
CURRENT $	13.4	20.1	25.2	30.7	27.5	28.8	33.0
1972 $	13.4	14.4	15.4	15.7	13.3		
TOTAL EMPLOYMENT (THOUSANDS)	526	502	503	457	398	346	—
AVERAGE HOURLY EARNINGS CURRENT $	4.89	7.39	8.94	10.65	11.50	12.67	—
CAPITAL EXPENDITURES (BILLION $)							
CURRENT $	1.2	2.3	3.3	2.9	2.0	—	—
1972 $	1.2	1.6	2.0	1.5	1.0	—	—
RATE OF RETURN ON INVESTMENT, %	2.34	1.24	2.87	3.98	2.11	—	—
REVENUE TON-MILES (MILLIONS)	800	800	900	900	800	—	—
FREIGHT REVENUE TON-MILES/ EMPLOYEE (MILLIONS)	1.5	1.8	2.0	2.2	2.2	--	--

EMPLOYMENT AND ANNUAL WAGES BY CLASS-1982

EMPLOYEE GROUP	AVERAGE NUMBER OF EMPLOYEES	TOTAL PAYROLL (BILLION $)	AVERAGE EARNINGS
EXECUTIVE, OFFICIALS	16,865	0.7	$42,094
PROFESSIONAL, CLERICAL AND GENERAL	80,044	2.1	26,218
MAINTENANCE OF WAY AND STRUCTURES	72,699	1.8	25,426
MAINTENANCE OF EQUIPMENT	75,004	2.0	26,341
TRANSPORTATION	18,010	0.5	28,403
YARDMASTERS	6,961	0.2	28,839
TRAIN AND ENGINE SERVICE	109,323	3.7	33,000
TOTAL	**378,906**	**11.0**	**29,084**

SOURCES: U.S. DOC/BIE: 1984 U.S. INDUSTRIAL OUTLOOK
U.S. DOL/BLS
ASSOCIATION OF AMERICAN RAILROADS: 1983 RAILROAD FACTS

The structural profile, Table 17-5, indicates that the top ten Class I railroads account for 75% of the operating revenues. These aggregated, for all railroads, to $28 billion in 1982. Coal is the leading commodity transported, representing 23.8% of total freight revenue and 41.3% of total tonnage freighted.

The railroad industry shows evidence of a secular trend towards reduction of the number of establishments, both through abandonment of the business by some railroads and mergers among the more successful ones which remain.

Number of Railroad Concerns	**1925**	**1955**	**1983**
Class I Line Haul	175	126	32
Other Line Haul	630	310	296
Switching and Terminal Companies	236	207	142
Total	**1041**	**643**	**470**

This trend is qualitatively identical to what has happened among all other nations beginning in the late 1800s. Elsewhere, the trend has culminated in nationalization, i.e., centralization of most or all of the rail establishments within a single, state-owned enterprise.

Competitive Issues Affecting the Railroad Industry

For obvious geographical reasons, there is no direct foreign competition to the U.S. domestic railroad transportation industry. Comparisons with foreign rail industries serve only as general indicators of efficiency, because conditions in other countries vary significantly from those in the U.S.

Productivity of the Railroad Industry

Figure 17-7 outlines the output and output per employee hour for the railroad industry from 1954 to 1982. Output for the

TABLE 17-5

STRUCTURAL PROFILE OF THE FREIGHT RAILROAD INDUSTRY

ESTABLISHMENTS (1983)

CLASS I	(>$50 MILLION OPERATING REV.)	33
CLASS II	(BETWEEN $10 & $50 MILLION)	26
CLASS III	(<$10 MILLION)	270
TOTAL		329

LEADING CLASS I RAILROADS

NAME	OPERATING REVENUES (BILLION$)	PERCENT OF TOTAL
BURLINGTON NORTHERN	3.7	14.3
CONRAIL	2.8	11.1
ATKINSON, TOPEKA, SANTA FE	2.0	8.0
SOUTHERN PACIFIC	1.9	7.5
UNION PACIFIC	1.7	6.8
NORFOLK AND WESTERN	1.7	6.5
MISSOURI PACIFIC	1.6	6.4
SOUTHERN RAILWAY SYSTEM	1.6	6.1
SEABOARD COAST LINE	1.2	4.5
LOUISVILLE AND NASHVILLE	1.1	4.2
TOTAL	19.3	75.4

DISTRIBUTION OF OPERATING REVENUES	LABOR	ENERGY	MATERIALS MISC. EXPENDITURES	CAPITAL
BILLION $, 1982	55.7	11.2	31.3	8.5

COMMODITIES TRANSPORTED

AS A PERCENTAGE OF TOTAL TONS AND TOTAL REVENUES

	TONS	REVENUE
COAL	41.3	23.8
FARM PRODUCTS	10.5	8.7
CHEMICALS AND ALLIED PRODUCTS	7.2	11.1
NONMETALLIC MINERALS	6.7	3.2
FOOD AND KINDRED PRODUCTS	6.0	9.8
LUMBER AND WOOD PRODUCTS	5.2	4.9
METALLIC ORES	4.9	1.5
STONE, CLAY, AND GLASS PRODUCTS	3.0	3.4
PULP, PAPER, AND ALLIED PRODUCTS	2.9	6.5
PRIMARY METAL PRODUCTS	2.5	3.7
PETROLEUM AND COAL PRODUCTS	2.5	3.3
WASTE AND SCRAP MATERIALS	1.8	1.6
TRANSPORTATION EQUIPMENT	1.5	7.4
TOTAL	**96.0**	**88.9**

SOURCES: U.S. DOC/BIE: 1984 U.S. INDUSTRIAL OUTLOOK
ASSOCIATION OF AMERICAN RAILROADS: ANALYSIS OF CLASS I RAILROADS, 1982; 1982 RAILROAD FACTS

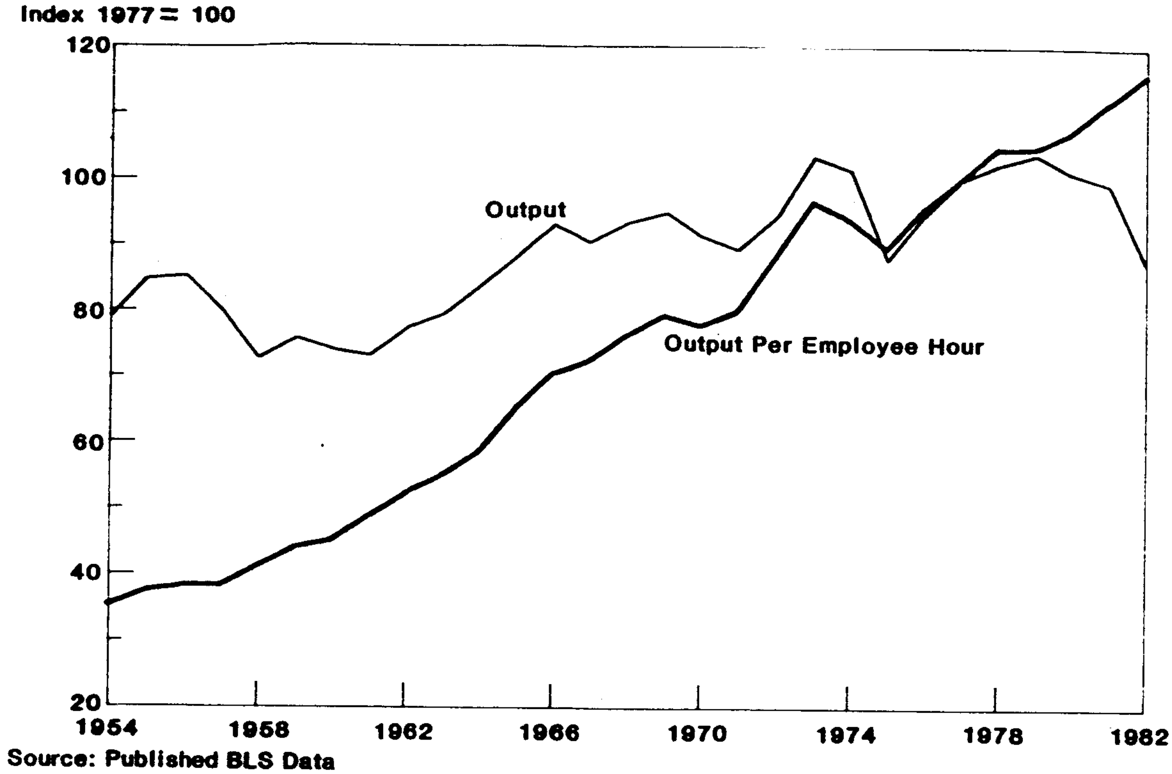


Figure 17-7. Output For The Railroad Industry

railroad industry as measured by the BLS is based on revenue traffic units.

Output grew at an average annual rate of 2.1% between 1960 and 1975. Between 1960 and 1967 the average annual growth rate was 3.7%; between 1967 and 1975, it dropped to 1.0%. Between 1976 and 1981 output increased at an average annual rate of 1%.

Output is expected to grow within the railroad industry as a result of several factors. One factor is the advantage railroads hold over the other modes of transportation in terms of the amount of fuel required to move freight. According to a study by the National Science Foundation, railroads (and waterways) are less energy intensive than any other freight mode except pipelines. Therefore, rises in fuel costs have a minor impact on the railroad industry's output. A factor of recently growing importance derives from the demand for coal as fuel for generating electricity. While the use of slurry pipelines for the transportation of coal has proven to be efficient, railroads have demonstrated, in several cases, that they were better able to compete with pipelines on a cost basis for this commodity.

Productivity in the railroad industry increased rapidly between 1947 and 1975: between 1947 and 1960 it rose at an average annual rate of 4.3% per year; from 1960 to 1975 it increased by 4.9% per year. Between 1976 and 1981 productivity rose at an average annual rate of 3.1%. The factors which contributed to this increase in productivity were new technology changes as well as increased capital expenditures for modernization. Physical productivity in the U.S. railroad transportation industry, as measured by ton-miles/employee, equaled 2.1 million in the U.S. in 1981, as opposed to 0.36 million for Japan.

The ratio between initial cost of goods at origin and the final cost of goods at destination can give an indication of industry efficiency. The average mine price of coal per ton in 1982 equalled $27.25. For the same year the average rail revenue per ton of coal was $12.04. Rail revenue as a percent of total delivered value per ton in 1982 thus equaled 30.6%. This indicates the efficiency of the rail industry with regard to coal transportation.

Research and Development

The R&D activities within the railroad industry have resulted in better, safer, and more cost-efficient operations. The Federal Railroad Administration (FRA) has been a cooperative partner in this railroad research.

In FY 1981 the FRA research budget exceeded $50 million. However, in 1983 the proposed budget only called for $20 million in FRA research, with most of it concentrating on safety issues. The FRA is also discontinuing its operation of the Transportation Test Center and transferring it to the Association of American Railroads. As a result, the private railroad industry will need to assume increased R&D responsibilities in order to maintain output and productivity growth. The railroad industry spends a negligible amount on R&D. In 1982, Class I railroads spent $15.6 million on R&D, equal to approximately 0.06% of the total revenues.

Technology Changes

Technology changes within the railroad industry are aimed at increasing freight haul productivity. These technology changes include motor power developments, increased car capacity, piggyback traffic, the application of computers, signaling and communication improvements, and automatic car identification. Table 17-6 outlines the major technological changes in the railroad industry.

Although railroads accounted for the highest percentage of all revenue freight ton-miles in the U.S. in 1982, that percentage has greatly decreased from 1929 when railroads accounted for 75% of all freight ton-miles. During the same period (1929-1982) the percentage of trucking and pipeline freight ton-miles increased by 19.4 and 19.6 respectively. Furthermore, since coal accounts for 23.8% of total revenues and 41.3% total tonnage, if slurry pipelines become a more efficient means of transporting coal, the railroad transportation picture may become bleak. Based on past history, it appears that the railroad industry is slowly trending toward an unspectacular maintenance of the status quo towards sunset. It also appears that no major deterioration ought to occur for the next ten years. There appear to be no "leapfrog" technologies that would drastically improve the slowly eroding railroad industry picture. In the foreseeable future, progress will be achieved by a series of relatively minor, integrated technological improvements aimed at increasing automation (reduction of the large component of labor costs) and speeding up the time required to move goods. Although railroads are a cost-efficient form of freight transportation (especially for heavy

TABLE 17-6

MAJOR TECHNOLOGY CHANGES WITHIN
THE RAILROAD TRANSPORTATION INDUSTRY

TECHNOLOGY	DESCRIPTION	APPROXIMATE ERA OF SIGNIFICANT DIFFUSION 1980 1985 1990 1995 2000
MOTIVE POWER DEVELOPMENTS	MORE POWERFUL DIESEL UNITS & HIGHER TRACTIVE POWER PER UNIT. (ALL CLASS I LOCOMOTIVES ARE DIESELS; APPROX. 2/3 WERE SECOND GENERATION IN 1975.)	
FREIGHT CAR IMPROVEMENTS		
• SELF-STEERING FREIGHT CARS	FREIGHT CAR WHEELS PARALLEL THE RAIL RATHER THAN EACH OTHER. (1,000 IN OPERATION ON THE CANADIAN NATIONAL RAILWAYS. STILL UNDER TESTING IN U.S.)	
• A-SHAPED CONTAINER	45 FOOT CONTAINER WITH AN EXTERIOR SHAPED LIKE THE BLOCK LETTER "A" THAT CAN BE STACKED TWO HIGH.	
• ROAD RAILER	A BOXCAR WITH RETRACTABLE FLANGED WHEELS AND RETRACTABLE RUBBER TIRES WHICH ENABLE THE CAR TO BE PULLED EITHER ON RAIL OR ROADWAY.	
PIGGYBACK AND UNIT TRAINS	TRAINS COMPRISED OF TRAILERS OR CONTAINERS LOADED ON FLAT CARS AND EXPEDITED ON STRICT SCHEDULES (4 MILLION TRAILERS & CONTAINERS CARRIED IN 1983).	
AUTOMATIC CLASSIFICATION YARDS	LARGE YARDS IN WHICH CARS ARE SORTED AND SWITCHED BY DESTINATION WITH THE AID OF COMPUTER (60 MAJOR YARDS NOW USING SYSTEM).	
CENTRALIZED TRAFFIC CONTROL (CTC)	CENTRAL CONTROL OF TRAIN MOVEMENT OVER STRETCHES OF TRACK OF 50-100 MILES OR MORE. (ONE-FIFTH OF ALL MAIN TRACK NOW OPERATED UNDER CTC.)	
SIGNALING AND COMMUNICATIONS		
• DETECTORS	MECHANICAL OR INFRARED DEVICES LOCATE AND REPORT DANGEROUS CONDITIONS IN EQUIPMENT ALONG THE RIGHT-OF-WAY.	
• MICROWAVE	HIGH-CAPACITY RADIO CARRIER WAVE USE TO SUPPLEMENT OR SUPPLANT WIRE MESSAGE CARRIERS (50,000 ROUTE MILES IN USE IN 1975).	
• AUTOMATIC CAR IDENTIFICATION (ACI)	REFLECTING LABELS PICKED UP BY TRANSMITTER, DECODED, & SENT TO CENTRAL OPERATIONS (85% IN USE NOW).	
MAINTENANCE OF WAY INNOVATIONS (MW)	USE OF SINGLE AND MULTIPURPOSE MACHINERY TO AID IN TRACK LAYING; TIE REPLACEMENT AND BALLEST SURFACING (MULTIPURPOSE MACHINERY USE INCREASING).	

SOURCE: U.S. DOL/BLS

materials), a principal factor against the railroad industry is the long transporting time. With truck and railroad combinations becoming more common, faster and more flexible service is expected. It may also result in the formation of large transportation conglomerates.

Conclusions

Railroad transportation is an energy efficient means of transportation, especially for heavy materials such as coal. However, the major drawback to railroad transportation is the time required to move goods. Some technologies that may work towards decreasing a portion of the time required to move goods via rail are:

- increased automation for the loading and unloading of freight from railroad cars;
- improved rail roadbeds which would allow for a higher train speed; and,
- rail and trucking joint ventures which would provide a faster and more flexible service.

B.17.4 INTERCITY TRUCKING (SIC 42)

Intercity trucking is the second largest commodity transporter in the U.S. in terms of ton-miles. In 1979, approximately 30% of U.S. intercity revenues for all modes of freight transportation were attributed to truckers regulated by the Interstate Commerce Commission (ICC). Combined regulated and non-regulated trucking accounted for approximately 68% of the total intercity freight revenue.

The U.S. trucking industry is comprised of approximately 18,000 regulated carriers. Carriers which are regulated by the

ICC are those intercity trucking carriers involved in interstate commerce. Intrastate and local trucking activities are not regulated by the ICC but by state and local authorities. Regulated carriers are classified into three classes: Class I with revenues over $5 million; Class II with revenues between $1 million and $5 million; and, Class III with revenues lower than $1 million. There are approximately 3,000 Class I and II carriers operating in the U.S. Carriers are also classified by type. General freight carriers are those which ship less than truck load (LTL)--each shipment in the truck is under 10,000lbs--or truck load (TL)--shipments in the truck weighs 10,000lbs or more--for the public on a for-hire basis. Specialized carriers transport commodities, such as liquid petroleum, motor vehicles, refrigerated products, and household goods, and are available to the public for-hire. Contract carriers transport mainly specialized commodities and some general freight.

The historical business profile of the intercity trucking industry is summarized in Table 17-7.

Output and Productivity Outlook of Intercity Trucking

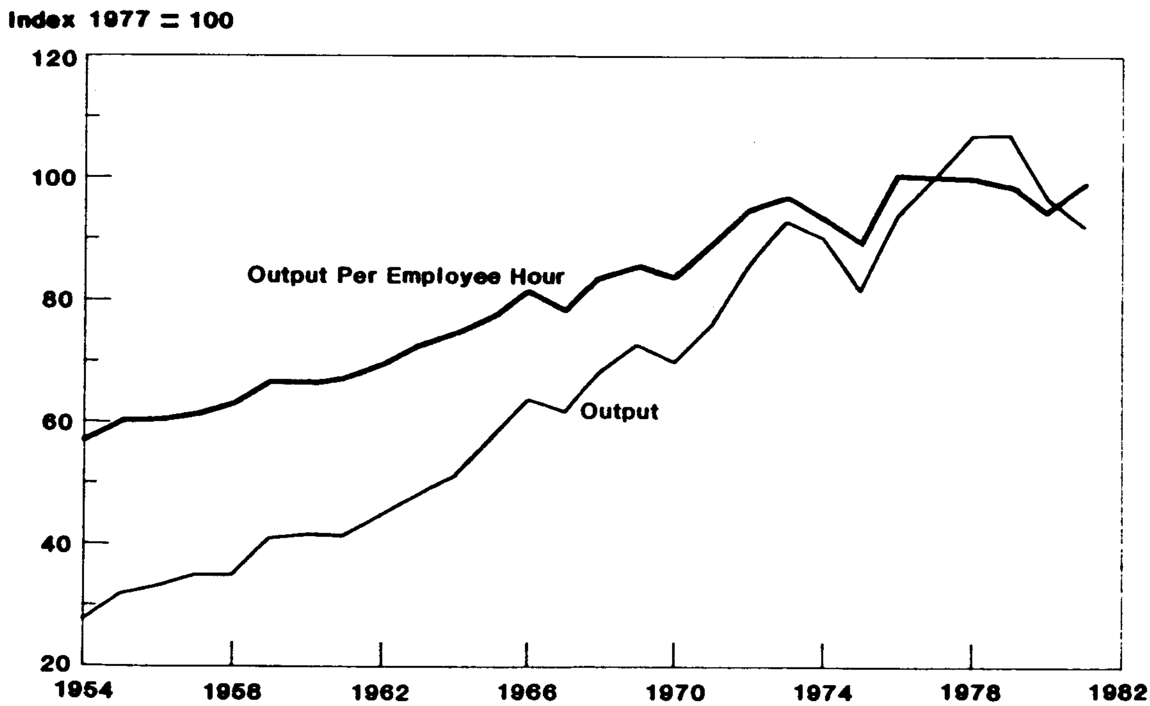
From 1960 to 1980, the productivity growth in regulated intercity trucking averaged 2.1% annually. For this same period the growth rate for the total nonfarm business sector was 1.2% annually. The high growth rate of the trucking industry has been attributed to the amount of new construction on the interstate highway system. Future productivity may be beneficially affected by regulatory reforms--size, weight, and speed laws--and less labor-intensive shipments.

The Motor Carrier Act of 1980 would eliminate, by July 1984, the antitrust immunity for collective ratemaking on freight carried by one trucking company, as opposed to freight carried by more than one trucking company. The Act reduced but did not

TABLE 17-7

BUSINESS PROFILE OF THE
INTERCITY TRUCKING INDUSTRY (SIC 421)

	1972	1977	1979	1981	1982	1983
REVENUES (BILLION$)						
CURRENT	69.0	74.9	93.5	111	106	113
1972 $	69.0	53.5	57.2	56.9	51.2	53.6
AVERAGE HOURLY EARNINGS, CURRENT $	4.96	7.23	8.50	10.12	10.43	10.75
TOTAL EMPLOYMENT (THOUSANDS)	1039	1127	1242	1159	1106	1150



Source: Published BLS Data

SOURCES: U.S. DOC/BIE: 1984 U.S. INDUSTRIAL OUTLOOK
U.S. DOC/BOC: STATISTICAL ABSTRACT OF THE U.S., 1983-4.
U.S. DOL/BLS

eliminate regulation. It reduced the ICC's administrative authority over entry and exit of firms in intercity trucking. Before the act went into affect, the ICC had control over the rates which the carriers set, and the carriers had antitrust immunity to operate rate-setting bureaus and their established rates were rarely questioned by the ICC. Under the new act, however, some collective ratemaking is restricted and other rate-setting practices may no longer have immunity after 1984. The act also eased the ICC's limitations on the commodities which are hauled by individual carriers and the routes over which the carriers can operate. This regulatory reform measure could improve the productivity of the regulated trucking industry by encouraging truckers to utilize equipment more efficiently, and by encourging the use of several modes of transportation. Furthermore, this regulatory reform should increase competition and, therefore, result in a greater volume of business for the regulated carriers.

The 1975 law issued by the federal government, which increased the maximum allowable weight in response to the lowered speed limits, may affect productivity favorably by reducing truck maintenance, driver fatigue, and accidents. Laws which increase the maximum width and length of truck trailers may also increase productivity by the utilization of fewer trucks to move an equivalent amount of freight.

Technology Changes

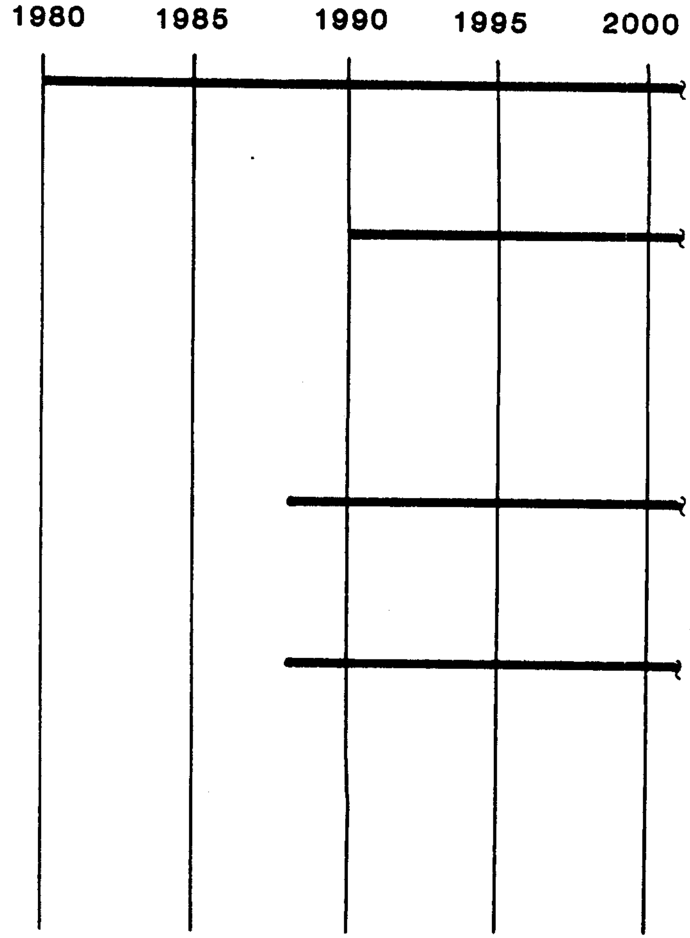
The diffusion of technological developments in the trucking industry was slow in the early 1970s; however, the increase in energy prices in the mid 1970s accelerated the diffusion rate of these technologies. Table 17-8 outlines the current major technological changes in the trucking industry. Since the diffusion of these technological developments has been rapid, corresponding changes in output and productivity are expected to increase quickly as well.

TABLE 17-8

MAJOR TECHNOLOGY CHANGES IN THE TRUCKING INDUSTRY

TECHNOLOGY	DESCRIPTION
GREATER CAPACITY TRUCKS	TWIN TRAILERS (40% OF ALL GENERAL FREIGHT LESS THAN TRUCKLOAD TON-MILES).
DIESEL-POWERED ENGINES	ENGINES RUN AT LOW SPEED & YIELD A 35% SAVING OVER GASOLINE (BY 1990 ALL HEAVIEST WEIGHT TRUCKS & 75% OF THE NEXT WEIGHT TRUCKS WILL BE DIESEL).
TRUCK BODY AND TIRES	LIGHTER WEIGHT TRUCK BODIES & TRAILERS & STEEL-BELTED RADIAL TIRES.
COMPUTER APPLICATIONS	PRIMARILY FOR RECORDKEEPING OF RATE & BILLING SCHEDULES. SOME SYSTEMS DEVELOPMENT TO CONTROL VEHICLES, DRIVERS, & SHIPMENTS. (NEARLY ALL CLASS I CARRIERS ARE USING ONE OR MORE COMPUTERS; MINI-COMPUTERS GROWING AMONG CLASS II CARRIERS.)

APPROXIMATE ERA OF SIGNIFICANT DIFFUSION



SOURCE: U.S. DOL/BLS

Potential Growth of the Industry

In 1929 trucking accounted for 3.3% of the total revenue freight ton-miles in the U.S. That percentage increased to 9.7 in 1939, to 16.3 in 1950, to 21.7 in 1960, and to 22.7 in 1982. While the total revenue freight ton-miles for the trucking industry has reached a plateau, its financial situation has been weakening. Thus, revenues for intercity trucking, as measured in constant 1972 dollars, decreased by 0.5% from 1979 to 1981. In 1982 the industry again experienced a decrease in revenues amounting to 10%. Although the industry did experience an increase in revenues of 4.7% from 1982 to 1983, the profit profile of the industry still remains dismal. The declining revenues within the trucking industry are due to a number of factors:

- High wages for regulated motor carriers;
- Deregulation and the resulting competitive environment;
- Increased gasoline and diesel fuel tax.

As a result, the long-term outlook for trucking may be unfavorable.

Wages account for nearly 60% of all operating costs in the trucking industry. The high competitive environment, resulting from deregulation, may eliminate some of the weaker carriers. Funds for new equipment are difficult to acquire by the industry, not only because of high interest rates but also because of the reluctancy of creditors to make loans to the industry.

The future growth of the trucking industry will depend not only on regulatory issues and the availibility of capital expenditures, but on new technological advances as well. These technological advances are contributed mainly by truck manufacturers and truck assemblers; however, some of the larger carrier fleets contribute to this process of implementing technical improvements.

Such new technological developments as electronic monitoring and control systems would improve efficiency, but only if widely adopted throughout the industry. To allow for widespread diffusion, new technologies must be inexpensive and highly reliable. New technological advances, with regard to make and design of motor vehicles, are discussed in Section B.2. Some of the technological advances in the motor vehicle industry may affect the trucking service section as well. "Leapfrog" technologies that would improve the trucking service industry would be technologies that are aimed at:

- increasing the speed of expediting freight;
- decreasing the time required to deliver goods; and,
- providing more flexible service.

B.17.5 AIR TRANSPORTATION (SIC 45)

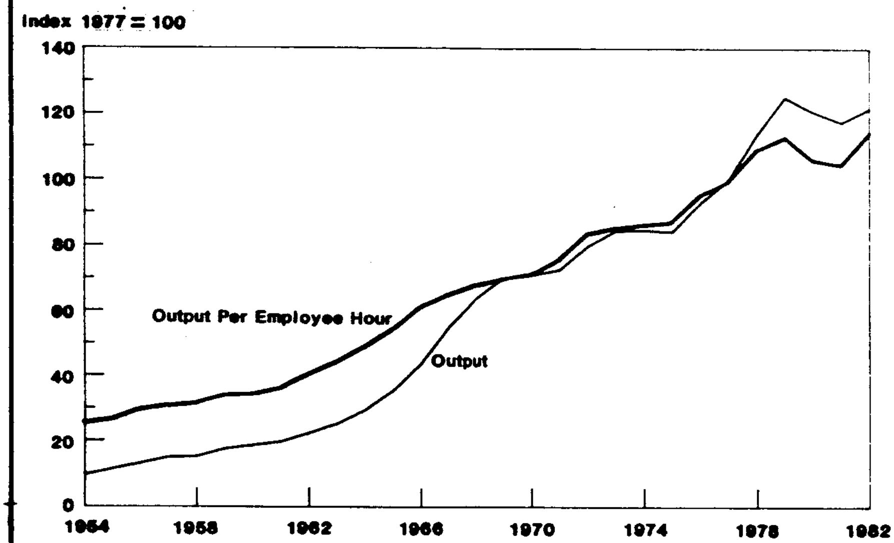
The air transportation industry holds the overwhelming share of intercity revenue passenger traffic--87% of all passenger miles in 1983. From 1978 to 1983 airlines experienced a passenger growth rate of 9% per year. The air transportation industry's revenues (combined revenues from passenger, air cargo and U.S. mail) for 1983 were $39 billion, which resulted in a combined operating profit of $310 million. The Air Transportation Association projects that the combined operating profit for 1984 will reach or exceed $1 billion, based on the first quarter of 1984.

The historical business profile of the air transportation industry is summarized in Table 17-9. Table 17-10 outlines the structural profile.

TABLE 17-9

BUSINESS PROFILE OF THE
AIR TRANSPORTATION INDUSTRY (SIC 451)

	1972	1977	1979	1981	1983
REVENUES (BILLION $)					
CURRENT $	11.2	19.9	27.2	36.7	39.0
1972 $	11.2	14.2	16.6	20.5	—
DOMESTIC					
CURRENT $	8.7	15.8	21.6	28.8	—
INTERNATIONAL					
CURRENT $	2.5	4.1	5.6	6.4	—
TOTAL EMPLOYMENT (THOUSANDS)	301	308	341	350	330



Source: Published BLS Data

	1972	1977	1979	1981	1983
AVERAGE HOURLY EARNING CURRENT $	5.82	7.99	8.82	10.58	10.98
RETURN ON INVESTMENT, %	—	10.9	7.0	5.3	5.9
REVENUE PASSENGER MILES BILLION $	—	193.2	262.0	248.9	281.3
FREIGHT TON MILES BILLION $	—	5.4	5.9	5.6	6.0
NO. OF PASSENGERS (MILLION $)					
DOMESTIC				286	318
INTERNATIONAL				21	22

SOURCES: U.S. DOC/BIE: 1984 U.S. INDUSTRIAL OUTLOOK
U.S. DOC/BOC: STATISTICAL ABSTRACT OF THE U.S., 1984
U.S. DOL/BLS
AIR TRANSPORTATION ASSOCIATION: 1984 ANNUAL REPORT OF THE U.S. SCHEDULED AIRLINE INDUSTRY
AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA: AEROSPACE FACTS AND FIGURES, 1983-4

TABLE 17-10

STRUCTURAL PROFILE OF THE
AIR TRANSPORTATION INDUSTRY (SIC 451)

NUMBER OF AIRLINES

MAJOR (>$1 BILLION REVENUES)	12
NATIONAL (REVENUES BETWEEN $75 MILLION-$1 BILLION)	15
LARGE REGIONALS (BETWEEN $10-$75 MILLION)	20
MEDIUM REGIONALS (<$10 MILLION)	48
TOTAL	95

LEADING FIRMS (1983)

NAME	NUMBER OF PAYING PASSENGERS DOMESTIC (BILLIONS)
UNITED AIRLINES	43.0
EASTERN AIRLINES	37.0
DELTA AIRLINES	36.8
AMERICAN AIRLINES	31.4
TRANS WORLD AIRLINES	18.6
REPUBLIC AIRLINES	17.7
US AIR	16.2
PAN AMERICAN WORLD AIRWAYS	14.1
NORTHWEST AIRLINES	12.7
PIEDMONT AVIATION	11.7
TOTAL	239.2

OPERATING EXPENSES OF U.S. CARRIERS
1982 ($ BILLION)

	DOMESTIC OPERATIONS	INTERNATIONAL OPERATIONS
FLYING OPERATIONS	11.5	2.6
MAINTENANCE	2.7	0.5
PASSENGER SERVICE	2.7	0.6
AIRCRAFT AND TRAFFIC SERVICING	4.7	0.9
PROMOTIONS AND SALES	4.2	1.0
DEPRECIATION AND AMORTIZATION	1.9	0.4
OTHER	1.9	0.5

SOURCES: AIR TRANSPORTATION ASSOCIATION: 1984 ANNUAL REPORT OF THE U.S. SCHEDULED AIRLINE INDUSTRY
AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA: AEROSPACE FACTS AND FIGURES, 1983-4

The business profile indicates that revenues increased by 83% from 1972 to 1981 as measured in constant 1972 dollars. The number of revenue passenger-miles increase by 46% from 1977 to 1983, and freight ton-miles increased by 11% during the same period. Although revenues, passenger-miles, and freight ton-miles have been increasing, the net profit margin was only 0.8% for 1983. This is, however, higher than the net operating profit margins of 1980, 1981, and 1982, which were -0.7%, -1.2%, and -2.0%, respectively. The reason for the lower than average net profit margin (the U.S. industry average is 5%) is rising costs, including increased interest expense. Interest expense for the airline industry was $1.2 billion in 1981, $1.4 billion in 1982, and $1.5 billion in 1983. Strong growth is projected for the airline industry, due in part to the deregulation of domestic freight and passenger air transportation. Since deregulation in 1977 the number of scheduled interstate carriers increased from 36 to 123, as a result of stronger competition and innovation.

The structural profile illustrates the leading firms, the breakdown of airlines in the U.S., and airline operating expenses. Of the ten leading firms, ranked by number of paying passengers, only one--Piedmont Aviation--does not exceed revenues of $1 billion.

Productivity Outlook of the Air Transportation Industry

The overall output of the air transportation industry experienced an average annual increase of 11.5% between 1960 and 1976, as measured by revenue passenger-miles, freight ton-miles, express ton-miles, and U.S. and foreign mail ton-miles. Between 1960 and 1966, the annual growth rate averaged 15.4% (see chart in Table 17-9). After 1966, however, the output declined, reaching low point during the 1974-75 recession, and then rose 10% in 1976. As a result, output grew only at an average yearly rate of 6.4% between 1966 and 1976. Between 1976 and 1982 the average annual growth rate was 4.6%. The future output of the industry appears promising as well, because of the continuing strong demand for passenger air transportation.

Dollar productivity in this industry grew at an average annual rate of 6.5% from 1960 to 1977; the sharpest rise was between 1960 and 1966 (10%) and the lowest rise was between 1967 and 1979 (4.4%). Compared to the average annual growth rate for all transportation (2.6%), air transportation demonstrated strong productivity. This strong growth rate is expected to continue through the 1980s.

Physical productivity as measured by freight and passenger miles per employee was 119.1 in 1979 (1977=100), 110.2 in 1981 and 131.9 in 1982. The drop in 1981 reflects the recessionary period when passenger miles decreased.

Technology Changes

The air transportation industry has not only been a growing-demand industry but has adopted several technological innovations as well. Technological changes within this industry are researched, developed, and implemented by private and public organizations. Current technological developments relate to improving reliability and fuel efficiency, reducing pollution levels, and developing sophisticated air control systems. While these technological developments have tended to be revolutionary in the past, future developments are expected to be more evolutionary in nature.

The FAA plays an important role in air transportation technology by establishing regulatory and operational provisions. Regulatory provisions include standards for design, performance, and maintenance of aircraft, aircraft engines, equipment, and instruments, and for certification of aircraft and air personel. Operational functions include the procurement, installation, operation and maintenance of air traffic control systems, and air navigation, communication, and surveillance facilities.

Table 17-11 outlines the current major technological changes in the air transportation industry. These technological developments are primarily aimed at lowering maintenance and fuel costs, meeting environmental requirements, and improving reliability.

Potential Growth of the Industry

New technological developments in the air transportation industry are expected not only to lower operating costs, but to increase productivity. The 1978 Airline Deregulation Act, which enabled airlines to expand, realign markets and restructure routes, has produced an increase in traffic. Future technological developments, aimed at reducing operating costs (e.g., fuel-efficient aircrafts), would further contribute to industry growth.

Based on past history, it appears that the air transportation industry is a "sunrise" industry. Passenger and freight traffic miles have been increasing steadily over the past two decades. "Leapfrog" technologies that would improve or accelerate the industry would be those aimed at efficient passenger processing and increased passenger services. The timeliness of scheduling, ticketing, and commuting to and from the airport, are areas in which passenger air transportation would benefit from technological developments. The easier the access to, from and through airport terminals, the more passengers are likely to utilize air transportation.

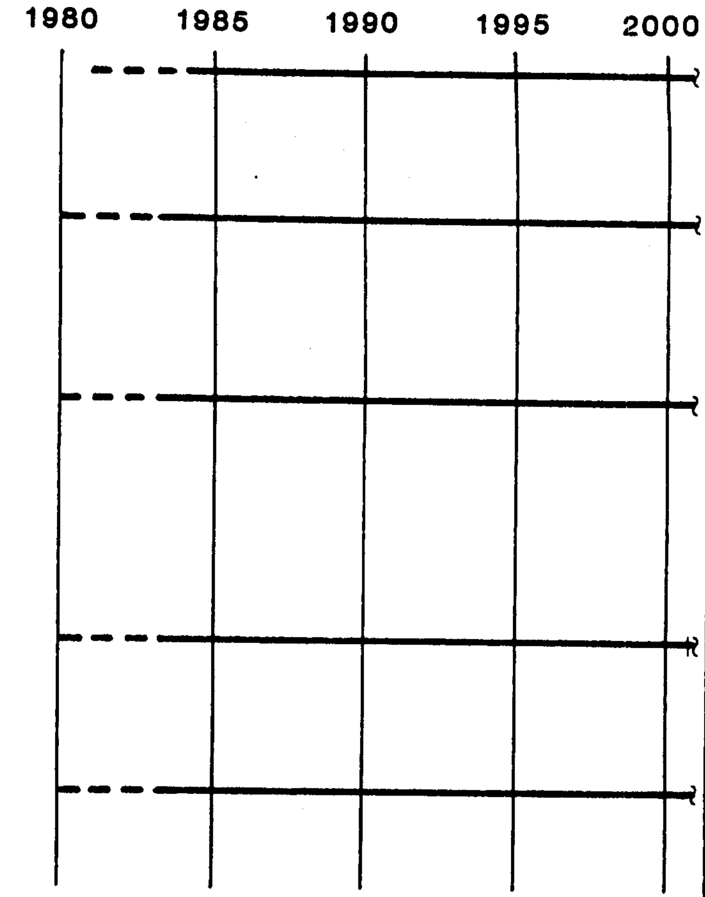
Many airports in the U.S. are increasing accessibility by connecting airports with other ground transportation services (e.g., metros, subways, railways, and bus lines). Furthermore, advanced customer services, such as voice and data communications to and from the flying aircraft to land telephone networks, will also lure passengers to air travel. Near-term technologies, such as Type II-all weather landing and the procurement of new generation air traffic control equipment, will also aid the industry.

TABLE 17-11

MAJOR TECHNOLOGY CHANGES IN AIR TRANSPORTATION

TECHNOLOGY	DESCRIPTION
DEVELOPMENTS IN FUEL-EFFICIENT AIRFRAMES AND ENGINES	FUEL-EFFICIENT, MEDIUM-SIZE, MEDIUM-RANGE JETS WITH IMPROVED TURBOFAN ENGINES.
ADVANCES IN NAVIGATION AIDS	MICROWAVE LANDING SYSTEM (MLS) WHICH ALLOWS FOR RELIABLE LANDING GUIDANCE IN ALL WEATHER.
DEVELOPMENTS IN SURVEILLANCE AND SEPARATION ASSURANCE PLANS	SURVEILLANCE AND DATA LINK SYSTEM (DABS) WHICH IMPROVES SURVEILLANCE, AIR TRAFFIC CONTROL COMMUNICATIONS, COLLISION AVOIDANCE.
DEVELOPMENTS IN TRAFFIC FLOW	AUTOMATED AIDS TO PILOT & CONTROLLER TO INCREASE EFFICIENCY OF TRAFFIC FLOW.
AUTOMATED AIRPORT TERMINAL SERVICES	USE OF SCANNING MACHINES AT TERMINALS TO CONFIRM RESERVATIONS AND ISSUE TICKETS.

APPROXIMATE ERA OF SIGNIFICANT DIFFUSION



SOURCE: U.S. DOL/BLS

Technologies such as air traffic control by space navigation means, projected for use after the year 2000, will also aid the industry by providing timely arrivals and departures, and may even increase the number of scheduled flights. With increases in the number of passengers, revenues will increase and costs will decrease, since airlines would be utilizing all available seating.

B.17.6 WATER TRANSPORTATION (SIC 44)

The water transportation service subsector, SIC 44, includes establishments engaged in freight and passenger service transportation on the open seas and inland waters, and establishments furnishing supporting services, such as lighterage, towing, and canal operations. The water transportation services industry can be subdivided into two categories: international and domestic water transportation.

International water transportation moves cargo between the U.S. and foreign countries. Approximately 70% of all U.S. international trade travels by water with the remainder either moving by air or by land between contiguous nations. The U.S. is a major shipper and receiver, but U.S. flag ships carry a minority of the cargo transported between the U.S. and other countries, and even less between other nations. In 1977 U.S. flag ships transported only 4.5% of the total U.S. oceanborne international trade.

Domestic water transportation includes three distinct transportation systems: coastwise transportation, Great Lakes transportation, and inland waterways. Coastwise transportation refers to the movement of cargo along the Atlantic, Gulf, or Pacific coasts, and intercoastal shipping between these coasts. The Great Lakes transportation includes not only shipping activities within the Great Lakes, but also in the St. Lawrence Seaway. The third domestic water transportation system, inland waterways, consists of the various inland and intracoastal waterways, rivers, canals, channels, and other natural and man-made mediums. The Mississippi River and its tributaries form the largest single part of the inland waterways system. Approximately 54% of all domestic waterborne commerce in the U.S. is transported on internal waterways: 25% is coastal traffic, 11% is Great Lakes traffic, and the remaining 10% is local waterway traffic.

The water transportation industry has shown a growth in both domestic and foreign waterborne commerce since 1960. Domestic commerce grew at a rate of approximately 1.9% per year between 1960 and 1979; foreign commerce grew at 6.2% annually during the same period.

The expansion of U.S. waterborne commerce since 1960 has been facilitated by several technological changes in the industry, see Table 17-12. These changes have had an impact on labor requirements, the size and cargo capacity of ships, and productivity.

The U.S. Coast Guard (USCG) and the Corps of Engineers (COE) are primary developers of new technologies oriented toward improving benefits/costs in the industry. Several of these new technologies, however, have not been incorporated or will not be incorporated until some time in the future, because of current benefit/cost constraints. The COE orients its research to the objective of enhancing and facilitating the volume of traffic; the USCG towards safety and strategic police functions.

Some of the objectives of principal COE technologies are:

- standardization of lock capacities and the increased speed of traversing locks;

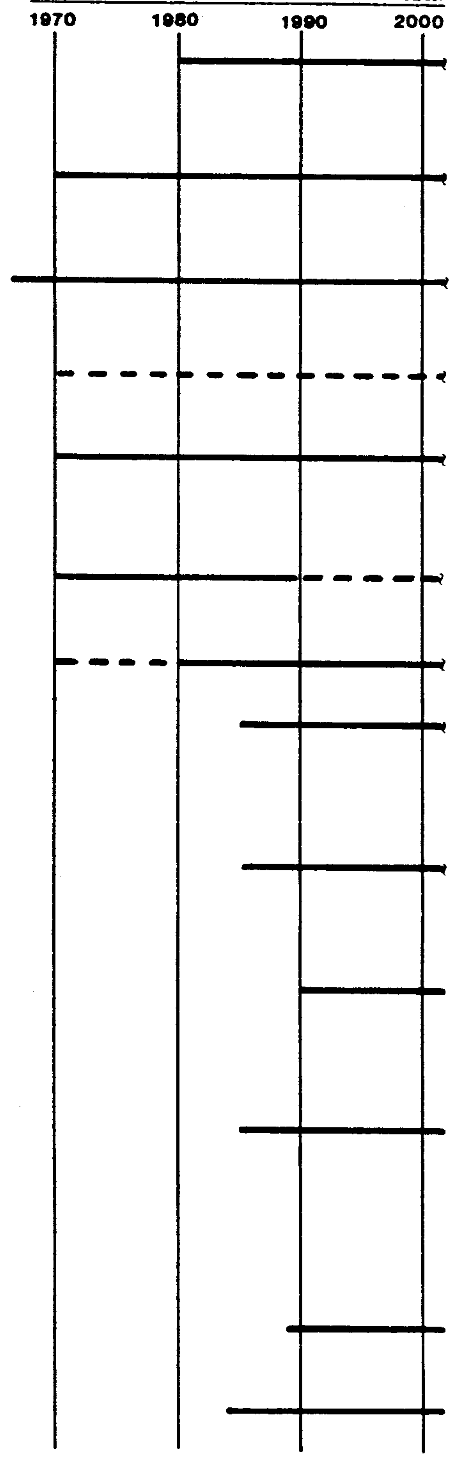
- improvement of navigable tracks between locks;

TABLE 17-12

MAJOR TECHNOLOGY CHANGES IN WATER TRANSPORTATION

TECHNOLOGY	DESCRIPTION
CARGO CONTAINERIZATION	CARGO IS PACKED INTO 20 OR 40 FOOT CONTAINERS PRIOR TO BEING LOADED ON A SHIP. REDUCES CARGO HANDLING TIME.
INCREASED CARGO CAPACITY	AN INCREASED CAPACITY FROM 14,000 DEADWEIGHT (DWT) TONS TO 37,400 DWT.
CENTRALIZED ENGINE CONTROLS	ALL ENGINE CONTROLS IN ONE LOCATION. SOME COMPUTERIZATION.
INCREASED USE OF DIESEL ENGINES	FUEL-EFFICIENT DIESEL ENGINES.
BOW THRUSTS	SMALL PROPELLERS INSTALLED IN FRONT OF SHIPS TO INCREASE MANEUVERABILITY IN CONGESTED AREAS.
IMPROVED MARINE COATINGS	RESISTS CORROSION AND WEAR CAUSED BY EXPOSURE.
INNOVATIONS ABOARD GREAT LAKES FREIGHTS	LARGER SHIPS, AND SELF-UNLOADING EQUIPMENT.
VESSEL TRAFFIC MANAGEMENT SYSTEM (VTMS)	ALLOWS FOR COORDINATION OF TRAFFIC DIRECTED TOWARDS LOCKS THROUGH THE USE OF RADAR, COMPUTERS, & RADIO COMMUNICATIONS.
PERFORMANCE MONITORING SYSTEM (PMS)	KEEPS TRACK OF THE PERFORMANCE OF LOCKS, i.e., SPEED OF FILLING & EMPTYING, TIME OF PASSAGE, TYPE OF CONVOY.
EXTENDED PMS	UTILIZATION OF A NATIONAL NETWORK, INCLUDING 25 COMPUTERS ACCESSIBLE TO ALL SUBSCRIBING SHIPPERS & LOCK MANAGERS.
LOCK COMMAND AND CONTROL SYSTEM	CONSISTS OF VIDEO CAMERAS, SENSORS, & COMPUTER DISPLAYS TO PERMIT THE LOCK MANAGER TO OBSERVE AND MODIFY THE PASSAGES, INCLUDING THE FUNCTION OF THE DETAIL SUBSYSTEMS OF THE LOCKS SUCH AS PUMPS, DOORS, ETC.
GLOBAL POSITIONING SYSTEM	WILL ALLOW CONVOYS TO SELF-NAVIGATE.
TRAINING SIMULATORS FOR WATERWAY PILOTS	

APPROXIMATE ERA OF SIGNIFICANT DIFFUSION



SOURCE: U.S. DOL/BLS

- methods and techniques for containment of erosion, sedimentation, and shoaling;
- dredging technology;
- technologies and techniques to extend the navigable period of time, especially in ice bound areas;
- technologies and techniques for management of traffic.

Output of Water Transportation

Between 1960 and 1979, domestic waterborne commerce in the U.S. experienced an average annual growth rate of 1.9%. Domestic waterborne commerce accounted for 52% of all commerce, which was a decrease of 17% from 1960. Commerce in the Great Lakes Region decreased from 155.1 million short tons in 1960 to 142.7 million short tons in 1978.

Foreign commerce increased at an average annual rate of 6.2% between 1960 and 1979. In 1960 31% of the total U.S. waterborne commerce was foreign. In 1979 that percentage grew to 48%. Although the percentage of foreign commerce has increased, the percentage of U.S. oceanborne foreign trade carried by U.S. flag ships has declined. In 1960, 11% of all U.S. oceanborne foreign trade was carried by U.S. flag ships; in 1980 the amount transported by U.S. flag ships was less than 4%.

Future Outlook of Water Transportation

Ocean shipping plays an important and central role in world economy and trade, since all international trading of goods is transported by water. In 1979 the world maritime trade in goods reached an all-time high of 3.8 billion metric tons; in 1982, that figure dropped to 3.2 billion metric tons.

The U.S. maritime industry has experienced a decline from a major to a minor role among the larger nations. This may in part be due to the fact that U.S. maritime policies are outdated and do not adequately address critical maritime problems of national concern. An assessment of the U.S. maritime trade and technology, by the Office of Technology Assessment (OTA), indicates that major new or revised federal policies are needed if the U.S. maritime industries are to remain strong in the future.

The OTA analysis also suggests that there is a need for maritime research and development. At the present time there is no clear policy regarding the federal role in maritime R&D. The R&D program now under the authority of the Maritime Administration gives little attention to the impact of maritime R&D. OTA suggests that a congressionally defined federal role in future maritime R&D be established, which would include the following provisions:

- identify maritime R&D objectives;
- determine what R&D would be best carried out within the U.S. maritime industry and formulate indirect incentives for industry R&D;
- stimulate the transfer and coordination of technology from military, foreign, and other sources, and from within the industry;
- focus on high-risk areas and long-range problems that are not addressed adequately either within the industry or elsewhere;
- contribute to national goals.

The present condition of the U.S. shipping industry may be defined as nonprofitable. It is neither sunrise nor sunset.

Flag liner operators as a whole showed a loss for the first quarter of 1983. Some of the smaller companies, which are not well-capitalized, are left in a difficult financial position. The larger companies are, however, expanding their services by modernizing their fleets.

A long-term world trade assessment developed by OTA indicates that U.S. trade volume will increase throughout the 1990s, but at slower rates than in the past. Because of these slower projected trade growth rates, U.S. carriers will need increased service efficiency and capability in order to compete with the rapidly growing foreign-flag fleets for the limited available cargo.

LIST OF TABLES

LIST OF FIGURES

B.18 "COMMUNICATION SERVICES" (SIC 48)

TABLE OF CONTENTS

SOURCES: U.S. DOC/BOC:

Statistical Abstract of the U.S., 1984
Historical Statistics of the U.S., Colonial Times to 1970

U.S. DOC/BIE:

1984 U.S. Industrial Outlook
1983 U.S. Industrial Outlook

EOP/DMB:

Standard Industrial Classification Manual, 1972

U.S. DOL/BLS
Value-Line Investment Survey, 1984
Wire Journal International
Intech

B.18 "COMMUNICATION SERVICES" (SIC 48)

The ultimate purpose of communications is to provide the transfer of information between individuals, directly or through the intermediary of mechanical, electrical or electronic machinery.

Table 18-1 recapitulates the evolution of the major communications media in the U.S. It can be seen that this evolution has proceeded in conjunction with three technologies: the conventional, or classical (mail, books, newsprint); the electrical (telegraph and telephones, beginning in the latter half of the 19th century); and the electronic (radio and TV, beginning circa 1925).

In the SIC categorization, the transfer of information by conventional mail is included in subsector SIC 4311; by printed media (e.g., newsprint, books), in subsector SIC 27. Subsector SIC 48, Communication Services, comprises four subdivisions:

- Telephone Communications (SIC 481),
- Telegraph Communications (SIC 482),
- Radio and Television Broadcasting (SIC 483), and
- Other Communication Services (SIC 489).

Table 18-2 shows the major services provided by each subdivision. The subsector as a whole accounted for approximately 3.3% of the U.S. GNP in 1982. By the end of the decade, this percentage is forecasted by some to reach 5% of GNP, following the anticipated increased use of telecommunications services.

The largest subdivision, Telephone Communications (SIC 481), has been selected for further analysis.

TABLE 18-1

HISTORICAL EVOLUTION OF U.S. COMMUNICATIONS MEDIA

YEAR	BILLION PIECES OF MAIL	NEW BOOKS	NEWSPAPERS, PERIODICALS	TELEPHONE CONVERSATIONS Local & Long Distance Billion/Year	TELEGRAPH MESSAGES DOMESTIC & INT'L Million/Year	RADIO BROADCAST STATIONS	TV BROADCAST STATIONS
1900	7	6,300	26,000	2.8	63	—	—
1925	25	9,600	14,000	25	192	571	—
1940	28	11,300	19,700	36	208	850	2
1950	45	11,000	19,000	62	200	2,900	104
1970	85	36,000	21,000	177	102	6,830	3,371
1975	89.2	39,400	21,000	228	68	5,335	4,440
1980	106.3	42,300	19,800	287	75	5,878	5,167
1982	114	46,900	19,900	312	74	N/A	N/A

SOURCES: U.S. DOC/BOC: STATISTICAL ABSTRACT OF THE U.S., 1984
HISTORICAL STATISTICS OF THE U.S., COLONIAL TIMES TO 1970

TABLE 18-2

CLASSIFICATION OF MAJOR SERVICES OF THE COMMUNICATION SERVICES INDUSTRY (SIC 48)

SIC CODE	SUBDIVISION DESIGNATION AND TYPICAL PRODUCTS	% TOTAL REVENUES
481	**TELEPHONE COMMUNICATIONS** TELEHONE CABLE SERVICE (LAND OR SUBMARINE) AND TELEPHONE (WIRE, RADIO OR SATELLITES). INCLUDES MARINE, MOBILE, AND AERONAUTICAL SERVICES WHICH PLACE PARTIES IN VOCAL COMMUNICATION WITH EACH OTHER. PAGING AND TELEPHONE ANSWERING SERVICES ARE CLASSIFIED IN SIC 73.	80.5
483	**RADIO AND TELEVISION BROADCASTING** RADIO BROADCASTING STATIONS, SUBSCRIPTION OR CLOSED CIRCUIT TELEVISION, TELEVISION BROADCASTING STATIONS, TELEVISION TRANSLATOR STATIONS.	14.5
489	**COMMUNICATION SERVICES, NOT ELSEWHERE CLASSIFIED** CABLEVISION SERVICE, MISSILE TRACKING STATIONS, PHOTOTRANSMISSION SERVICES, RADAR STATION OPERATION, TELECOMMUNICATIONS, TRANSRADIO PRESS SERVICE.	3.7
482	**TELEGRAPH COMMUNICATION** RADIO TELEGRAPH, TELEGRAPH CABLE SERVICE (LAND OR SUBMARINE), TELEGRAPH (WIRE, RADIO, SATELLITE).	1.3

SOURCE: EPO/OMB: STANDARD INDUSTRIAL CLASSIFICATION MANUAL, 1972
U.S. DOC/BOC: STATISTICAL ABSTRACT OF THE U.S., 1984

B.18.1 TELEPHONE COMMUNICATIONS (SIC 481)

Since its beginning in 1876, the U.S. telephone system has grown to be the largest and the best in the world.

Three principal standards of telephone performance are: number of telephones per capita, quality of service and cost per message. Table 18-3 shows the number and per capita distribution of the world's telephones. Note that the U.S. holds more than one-third of all the world's phones. With the divestiture of AT&T, that number may increase to almost half of the world's phones, since consumers will not be charged for additional phones and will be able to purchase inexpensive imported phones.

"Quality of service" is measured as the percentage of calls which cannot be successfully completed for any reason other than the party being called is busy--i.e., blockage, excess noise, dropout, other causes. Table 18-4 shows the average calls per line nonresponse for selected countries.

Table 18-5 shows typical costs of long-distance domestic and international calls expressed in 1982 dollars. U.S. international toll rates are significantly less expensive when compared with those of selected foreign countries. A prime time call from the U.S. to Europe costs currently (1984) around $1.00 per minute; from Italy to the U.S. it costs $1.80 per minute; from France to the U.S. it costs $1.63 per minute. Telephone service has generally become more efficient, more convenient, and less expensive. With the addition of direct international calling, international telegraph message service may begin to decrease.

The business and structural profiles of the telephone industry are outlined in Tables 18-6 and 18-7. The business profile indicates that domestic operating revenues (as measured in constant 1972 dollars) have more than doubled from 1972 to 1983. International operating revenues tripled and the number of telephones in use increased by 54% during the same period.

TABLE 18-3

TELEPHONE USAGE FOR SELECTED COUNTRIES

COUNTRY	NUMBER IN USE (MILLION)	PER 100 POPULATION	PERCENT OF WORLD TELEPHONES
U.S.	180.4	78.8	35.5
SWEDEN	6.6	79.6	1.3
SWITZERLAND	4.6	72.7	0.9
CANADA	16.5	68.6	3.2
U.K.	26.6	47.7	5.2
F.R. GERMANY	28.5	46.4	5.6
JAPAN	53.6	46.0	10.6
FRANCE	24.6	45.9	4.9
ITALY	19.2	33.7	3.8
REST OF THE WORLD	147.6	3.6	29.0

SOURCE: U.S. DOC/BOC: STATISTICAL ABSTRACT OF THE U.S., 1984

TABLE 18-4

QUALITY OF SERVICE FOR SELECTED COUNTRIES

	CALLS PER LINE NONRESPONSE			
COUNTRY	STANDARD	WORST	AVERAGE	RATIO AVERAGE
U.S.	200	50	100	1
ITALY			3 TO 4	28
F.R. GERMANY			7 TO 10	12
FRANCE			4 TO 5	22
JAPAN			20 TO 50	3
CANADA			50 TO 200	1

TABLE 18-5

TELEPHONE TOLL RATES BETWEEN NEW YORK CITY AND SELECTED CITIES

(IN CONSTANT 1982 $--3 MINUTE CALL)

YEAR	PHILADELPHIA	CHICAGO	DENVER	SAN FRANCISCO	LONDON	CAIRO	TOKYO	BUENOS AIRES
1981	1.29	1.53	1.61	1.68	3.18	10.02	5.25	4.77
1979	1.29	1.49	1.57	1.66	5.69	11.39	9.30	8.55
1977	1.49	1.74	1.85	1.92	5.32	13.30	13.30	11.82
1975	1.48	1.97	2.14	2.24	5.92	14.80	14.80	13.16
1970	1.13	2.38	2.83	3.05	8.14	NA	20.36	18.10
1965	1.39	3.90	4.73	5.56	NA	NA	25.04	NA
1960	1.50	4.37	5.42	6.78	NA	NA	NA	NA
1952	1.79	5.37	7.88	8.95	NA	NA	NA	NA
1946	2.11	7.28	10.33	11.74	56.36	56.36	56.36	56.36
1940	3.21	13.56	23.19	28.55	149.89	214.13	139.19	107.07
1937	3.17	15.49	31.69	45.77	147.88	211.27	216.55	147.88
1930	3.18	19.07	38.14	57.22	190.72	NA	NA	190.72
1927	3.76	20.36	37.59	56.39	469.92	NA	NA	NA
1919	3.00	25.38	56.76	90.07	--	--	--	--
1911	NA	NA	121.10	222.82	--	--	--	--
1902	6.91	68.55	NA	NA	--	--	--	--

TABLE 18-6

BUSINESS PROFILE OF THE TELEPHONE AND TELEGRAPH SERVICES INDUSTRY (SICs 481 AND 482)

	1972	1977	1979	1981	1983	1984 EST.
OPERATING REVENUES BILLIONS						
• DOMESTIC						
CURRENT $	25.8	44.1	54.8	70.8	86.9	95.8
1972 $	25.8	38.2	49.0	53.7	59.5	62.5
• INTERNATIONAL						
CURRENT $	0.7	1.3	1.9	2.2	2.5	2.9
1972 $	0.7	0.9	1.2	1.1	1.2	1.3
TOTAL EMPLOYMENT (THOUSANDS)	1002	975	1070	1095	1100	1120
NO. OF TELEPHONES (MILLIONS)	132.0	162.0	175.2	181.9	189.0	203.2
CAPITAL EXPENDITURES (BILLION 1972 $)	10.5	14.7	20.2	23.3	21.1	N/A
GROSS CUMULATIVE PLANT INVESTMENT (BILLIONS)						
CURRENT $	84.4	131.2	155.2	155.2	186.8	216.9
1972 $	84.4	93.7	94.9	79.5	N/A	N/A

SOURCES: U.S. DOC/BIE: 1984 U.S. INDUSTRIAL OUTLOOK
U.S. DOL/BLS

TABLE 18-7

STRUCTURAL PROFILE OF THE TELEPHONE AND TELEGRAPH SERVICES (SICs 481 AND 482)

LEADING FIRMS (INDEPENDENT)

NAME	REVENUES 1984 EST. (BILLION $)
GTE CORP	9.2
MCI COMMUNICATIONS	2.4
CONTINENTAL TELECOM	2.3
UNITED TELECOMMUNICATIONS	2.2

LEADING FIRMS (BELL AFFILIATES)

NAME	REVENUES 1984 EST. (BILLION $)
AMER. TELE.	33.3
NYNEX CORP.	9.8
BELL SOUTH CORP.	9.5
AMER. INFO. TECH.	8.4
BELL ATLANTIC	8.3

TOTAL NUMBER OF INDEPENDENT TELEPHONE COMPANIES, 1982: 1432

	1880	1900	1920	1940	1960	1970	1980
AVERAGE DAILY CONVERSATIONS (1,000)							
• LOCAL	237	7,689	50,207	95,625	273,322	458,400	707,000
• LONG DISTANCE	2	193	1,607	3,158	12,064	26,800	70,000
• INTERNATIONAL	—	—	—	—	9	64	546
NO. OF TELEGRAPH MESSAGES HANDLED (1,000)							
• DOMESTIC	55,879	63,168	155,884	191,645	124,319	69,679	55,000
• INTERNATIONAL	—	4,387	16,619	22,578	28,278	32,241	20,000
NO. OF TELEPHONES PER 1,000 POPULATION	1.1	17.6	123.4	165.1	407.8	583.4	790

RETURN ON INVESTMENT, %	1950	1955	1960	1965	1970	1975	1979	1981
• TELEPHONE	6.1	6.6	7.3	7.3	7.1	7.6	8.5	9.0
• DOMESTIC TELEGRAPH	5.1	7.6	5.0	5.6	5.0	6.1	5.5	7.4
• OVERSEAS TELEGRAPH	7.3	5.8	7.2	11.0	10.6	12.0	17.9	12.5

SOURCES: U.S. DOC/BOC: HISTORICAL STATISTICS OF THE UNITED STATES COLONIAL TIMES TO 1970
VALUE-LINE INVESTMENT SURVEY, 1984

The divestiture of American Telephone and Telegraph (AT&T) on January 1, 1984 resulted in the formation of seven companies to assume ownership of the 22 divested Bell Operating Companies. AT&T now consists of Western Electric Company, Bell Laboratories, AT&T Communications (intrastate, interstate and international long distance), AT&T International (overseas sales), and AT&T Information Systems. These seven regional companies will provide methods and systems for network planning, local exchange service, access to long distance networks of interchange carriers, and other telecommunication services (e.g., cellular radio mobile service and printed directory services). AT&T will continue to operate the long distance interstate exchange network and continue to own customer premises equipment. In addition, AT&T will undertake business ventures in evolving information markets.

The divesture of AT&T is not the only structural change that has or will be taking place in the telephone communications service industry. Many companies are expanding their operations to include fiber optics, satellite services, cellular radio, digital electronic mail systems, and other data communications, in order to accommodate the rapidly changing technological and competitive environment.

Productivity in Telephone Communications

Productivity for the telephone communications industry, measured in terms of operating revenues per employee hour, grew at an average annual rate of 5.5% between 1960 and 1977. This productivity growth can be attributed to the introduction of new advanced technologies, which have reduced labor requirements in the industry.

Physical productivity for the telephone services industry, measured in terms of the total number of messages per total number of employees, is outlined in Table 18-8. Physical productivity for this industry is shown to have increased significantly since 1876. A slight decline in productivity emerged between 1980 and 1982.

TABLE 18-8

PHYSICAL PRODUCTIVITY FOR THE TELEPHONE SERVICES INDUSTRY
(NUMBER OF MESSAGES PER YEAR/NUMBER OF EMPLOYEES PER YEAR)

YEAR	PRODUCTIVITY
1880	10.68
1890	19.49
1900	27.81
1925	31.42
1940	46.99
1950	42.71
1970	82.21
1975	100.00
1980	112.72
1982	112.03

INDEX: 1975 = 100.00

Role of Technology in Long-Term Strategic Outlook

The U.S. telephone communications industry has historically been active and still holds a dominant position in U.S. technological development. The technology of the telephone has drastically changed since its commercialization in 1877; the basic principle of telephone transmission has been modified.

In 1983, there were approximately 189 million telephones in use in the U.S.; in 1981, 97% of all U.S. households had telephone service. On the average there are currently two telephones per household in the U.S., a number that is expected to increase following the recent divestiture of AT&T. Even if purchases of conventional telephones reach a saturation point, new technological changes will encourage consumers to purchase new telephone sets with added features and capabilities.

Continuing development of innovative technologies will lead to further expansion in the telephone communications services industry: for example, computer communications. Semiconductor companies are beginning to combine their technologies through cooperative agreements, joint ventures, licensing and investments. These associations promote a highly competitive environment and may contribute to the maintenance of the U.S. leadership in the world community. Additional technological advances include digital switches, satellite communications, fiber optics, and cellular telephones. The changeover to digital switching will provide greater flexibility and a wider range of services for the user. Table 18-9 outlines the communications service technologies and their principal service impact.

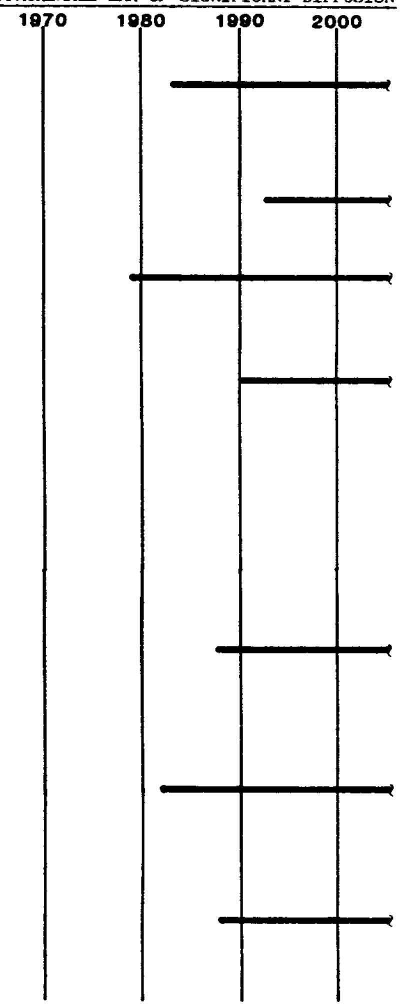
Satellite communications, which were initiated over two decades ago, have become a primary agent of growth in the U.S. telecommunications industry. A phenomenal growth in the use of communication satellites has occurred since the launch of the first commercial satellite, Early Bird, in April 1966. In barely 15 years, the worldwide commercial INTELSAT system has progressed through six generations of increasingly higher capacity satellites to keep pace with the growing traffic demand. In 1983, INTELSAT's space segment consisted of 18 satellites providing communications to over 600 Earth stations spread over many nations. Some 30,000 voice circuits are in full-time use in the INTELSAT system today. By 1987, a single INTELSAT VI satellite will have a capacity of 33,000 voice circuits--a significant improvement over the 140 voice circuits provided by Early Bird in 1966. The INTELSAT VI series will raise the cumulative INTELSAT purchases-satellites plus launches--to almost $3 billion in current dollars. Satellite communications are now responsible for 60% of the world's intercontinental telecommunications; the U.S.

TABLE 18-9

COMMUNICATION SERVICE TECHNOLOGIES

TECHNOLOGY	DESCRIPTION	PRINCIPAL IMPACT
SATELLITE COMMUNICATIONS	USE OF SATELLITES TO TRANSMIT VOICE, VIDEO, & DATA BOTH INTER & INTRA CONTINENTALLY.	● PROVIDES AN ALTERNATIVE TO UNDERSEA CABLES. ● COLOR TV TRANSMISSION ON A LEASED PRIVATE LINE BASIS.
MOBILE SATELLITE COMMUNICATIONS	RELAYS MOBILE COMMUNICATIONS FOR RURAL AREAS.	● RADIO TELEPHONE. ● DISPATCH. ● PAGING.
DIRECT BROADCAST SATELLITES	DIRECT TRANSMISSION FROM SATELLITE TO HOME.	● COLOR TV TRANSMISSION.
FIBER OPTICS	TRANSMISSION OF VOICE, VIDEO & DATA LIGHT WAVES VIA SILICA OR GLASS FIBER.	● WIDE BANDWIDTH WILL ALLOW THE FOLLOWING SERVICES: - FULL MOTION VIDEO - TELECONFERENCING - METER READING - ELECTRONIC MAIL - VIDEOTEST - TELETEXT - ELECTRONIC TELEPHONE DIRECTORIES.
CELLULAR MOBILE TELEPHONE	ALLOWS FOR FREQUENCY REUSE IN SERVICE AREA THROUGH LOW POWER ANTENNAS COVERING CELLS AS SMALL AS 1 MILE IN DIAMETER.	● MOBILE TELEPHONE SERVICE.
WIRELESS PHONE	BATTERY POWERED PORTABLE CORDLESS TELEPHONES.	● PROVIDES THE USER TO TAKE OR MAKE CALLS FROM UP TO 700 FEET FROM THE BASE STATION.
ELECTRONIC SWITCHING SYSTEM	HIGH SPEED COMPUTER-BASED SWITCHING EQUIPMENT.	● PROVIDES ADVANCED DIALING CAPABILITIES - CALL FORWARDNG - SPEED CALLING - CALL SWITCHING - THREEWAY CALLING.

APPROXIMATE ERA OF SIGNIFICANT DIFFUSION



SOURCE: U.S. DOL/BLS

domestic satellite market is experiencing a compounded annual growth rate of approximately 35%.

The demand for satellite communications is increasing worldwide, with the Western Hemisphere, principally the U.S., generating the bulk of the traffic. The early 1980s has witnessed an explosion in U.S. domestic satellite communications (DOMSAT) for commercial voice/data and television distribution from space. More than 40 U.S. DOMSATS will be in orbit by 1987, with the total cumulative investment approaching $3 billion. The spacecraft purchases for domestic applications started seven years later than those of INTELSAT, but the cumulative sales are expected to exceed those of INTELSAT by the mid 1980s. In future years, the DOMSAT market promises to grow much more rapidly than the INTELSAT market.

Direct broadcast satellites (DBS) are the most recent applications of the rapidly growing DOMSAT business in the U.S. and Canada. The Federal Communications Commission (FCC) has granted petitions to eight DBS applicants for television distribution to receive-only earth stations in the U.S. In a related action, in 1983 the FCC authorized the construction and launch of 19 additional DOMSATs to join the 20 satellites then serving the U.S. and Canada.

Domestic satellite communications appear to be heading towards a saturation phase, resulting from orbital crowding and other factors. A significant reversal of this saturation trend would be derived from the technology of fiber optics transmission. Fiber optic systems have several advantages over copper cable. The information-carrying capacity (bandwidth) of fiber cable is much higher than copper cable and, as a result, can carry large amounts of data. A single optical fiber 0.005mm in diameter can theoretically carry 500 million simultaneous telephone conversations. While only 2000 simultaneous telephone calls have been carried thus far on one fiber, this is still significantly greater than the 32 conversations that a pair of copper wires can handle. Another advantage of fiber optics is that signals fade far less rapidly than with copper wires. Metal cables require repeaters to boost signals every 2km; in optical fibers they are needed every 10-20km. The advantages of the fiber optic technology are outlined in Table 18-10.

Table 18-11 compares the costs of fiber optic cable with copper cable costs. These figures are estimates that are affected by such factors as transmission distances, the ability to place cable in existing trays, etc. Because of the rapid dropping of fiber costs, it is becoming more economical to install fiber cable than copper cable. South Central Bell Telephone Co. began offering fiber optic lines to large business customers in September of 1984. Their small basic fiber optics system, which offers 1.5 megabyte service, will cost $1,085 per month. For businesses with 1,000 or more telephone lines this would be a savings relative to what the costs are for standard copper wire service.

In 1982, approximately 170,000 kilometers of optical waveguide were installed worldwide; that number increased to about 270,000 in 1983. It is projected that the U.S. fiber optics market will reach $400 million in 1984. Approximately 58% of the market is estimated to go to telecommunications, 22% to the military, 16% to computer interconnect, and 4% to video.

The present capacity of the U.S. fiber optic network is not being fully exploited. The network between New York and Washington, D.C., for example, is operating at approximately 30% of capacity.

The divestiture of AT&T, however, is expected to encourage other common carriers in the U.S. to install fiber optic networks. In addition, AT&T is planning to install 16,000 route km of fiber optic systems as a basis for a nationwide fiber optics

TABLE 18-10

ADVANTAGES OF LOW-LOSS OPTICAL WAVEGUIDE

FEATURES	BENEFITS
LOW LOSS	• INFREQUENT REPEATER
LARGE BANDWIDTH	• LOW COST PER CHANNEL • EXPANSION CAPABILITY • HIGH INFORMATION RATES
SMALL SIZE	• SPACE SAVINGS
LOW WEIGHT	• WEIGHT SAVINGS
FLEXIBILITY	• EASE OF INSTALLATION
RADIATION RESISTANCE	• SURVIVABILITY
IMMUNITY TO EMI AND EMP	• RELIABILITY • SHIELDING COST
DIFFICULT TO TAP	• SECURITY
DIELECTRIC	• ELECTRICAL ISOLATION • SAFETY FROM CROSSTALK • SAVINGS OF COPPER

SOURCE: WIRE JOURNAL INTERNATIONAL

TABLE 18-11

POINT-TO-POINT COST AND PERFORMANCE COMPARISONS FOR REPRESENTATIVE METALLIC AND FIBER OPTIC CABLE ALTERNATIVES

COST ELEMENT	TELEPHONE NETWORK	TWISTED PAIR	COAX	LO-SPEED FIBER	HI-SPEED FIBER LINK
• INTERFACE (EACH)	$1000	$500	$1500	$200	$850
• INTERFACE INSTALLATION (EACH)	$50	$50	$100	$50	$200
• CHANNEL	$50/MONTH	$50/FT	$75/FT	$1/FT	$1/FT
• CABLE INSTALLATION (PER FOOT)	---	$1-10	$3-10	$1	$1
TELEPHONE PERFORMANCE					
• MAX BIT RATE (BAUD)	0.5K	9.6K	1M	100K	20M
• MAX DISTANCE (MILES)	—	3	2	0.6	1

SOURCE: INTECH, MARCH 1984

network. Moreover, AT&T has been contracted to install 3,146 nautical miles of fiber optic cables as a foundation for the first transatlantic fiber optic system. The U.K. and France will be contributing 279 and 167 miles respectively to a transatlantic fiber optic system.

AT&T is also planning to build a fiber optics system which would connect Hawaii with the continental U.S. By connecting that system with the Japanese system, a U.S./Japanese fiber optic hook-up could be completed by 1988.

A fiber optic cable is being developed with new applications that will transmit not only voice but video and data as well. Another relatively new application of fiber optics is the linking of ground offices to earth stations. The use of fiber optics to link personal computers in the work place is increasing as well, because of their immunity from electromagnetic and radio frequency interference.

The use of fiber optics is also expected to grow in the video market; the first digital television system was installed in the U.S. in 1984. Fiber optics have the bandwidths required to operate a digital television.

Finally, fiber optics may play a role in the development of teletext and videotex systems. Teletext uses one-on-one communication channels to transmit data into a continuous cycle. It broadcasts pages of information directly to television receivers on unused portions of standard TV broadcast channels or cable television systems. A subscriber selects the desired display by using a decoder; merchandise can be selected, reservations secured, and other transactions completed which would be otherwise carried out by mail or telephone.

Videotex is a two-way communications system which links large databases to either terminals or microcomputers by telephone or cable lines. Videotex can retrieve information stored in a remote computer and display it on a monitor or television in color or black and white. This information may be displayed as words, numbers, graphs, or pictures with limited animation.

The number of worldwide videotex and teletext users in 1982 is outlined in Table 18-12. Videotex and teletext are not as popular in the U.S. as they are in foreign countries. It appears that the extent of implementation in the U.S. during the 1980s will depend not only upon customer acceptance, but also on the U.S. regulatory framework. It is projected that by 1987, approximately 5% of U.S. homes will have operational two-way systems which would include information retrieval, electronic messages, data processing, and telemonitoring (remote sensing of fire and intruders, and energy management controls).

France has been experimenting with electronic telephone directory service. Terminals were given to residents which enabled them to access both videotex bases and telephone directory information. Telephone companies in many countries are writing for the results of this project. If the results indicate that the electronic directories are acceptable to telephone subscribers, paper directories will probably be replaced by electronic directories. Market research suggests that if the change from paper to electronic directories does occur, consumers will not be additionally charged for the service.

While videotex systems are commercially available in the U.S. at present, new technology developments in this area are expected to include improved transmission speed, graphic resolution, hard copy, speech music and full motion video. This future insurgence of videotex systems will dramatically change the communications field by creating a scenario in which a computer terminal or a microcomputer is accessible to every U.S. household.

TABLE 18-12

WORLDWIDE VIDEOTEX AND TELETEXT USER BASES
(AS OF SEPTEMBER 1982)

REGION	COUNTRY	VIDEOTEX USERS	TELETEXT USERS
NORTH AMERICA	U.S.	2,475	695
	CANADA	2,945	55
LATIN AMERICA	BRAZIL	1,500	---
	VENEZUELA	35	---
EUROPE	U.K.	18,675	450,000
	GREECE	8,500	---
	F.R. GERMANY	7,764	150,000
	AUSTRIA	6,000	120,000
	FRANCE	5,768	1,500
	THE NETHERLANDS	4,700	170,000
	ITALY	1,000	—
	SWEDEN	550	100,000
	FINLAND	450	20,000
	SPAIN	400	—
	DENMARK	300	1,000
	SWITZERLAND	150	10,000
	NORWAY	100	300
	BELGIUM	NA	20,150
AFRICA	SOUTH AFRICA	500	—
FAR EAST	JAPAN	3,500	—
	HONG KONG	2,500	—
	AUSTRALIA	10	1,500
	SINGAPORE	NA	--
	TOTAL	**67,822**	**1,045,200**

SOURCE: U.S. DOC/BIE: 1983 U.S. INDUSTRIAL OUTLOOK

Another area of technological advancement in the communications service industry is cellular telephone service. The evolution of cellular telephone service began as an outgrowth of the Improved Mobile Telephone Service (IMTS), which was established in 1964 to eliminate operator intervention in mobile telephone calls. The IMTS operates on 33 frequency channels operated from large master antennas. Frequencies used in one city cannot be used in a nearby city because of interference risks. Long radio links are vulnerable to noise because an IMTS antenna only covers an area of 50 miles in diameter. IMTS also implements multi-channel trunking which allows each user to search and access several two-way channels in order to find one available for calling. Current cellular systems operate on 666 frequency channels.

Cellular telephones differ from the IMTS service in that the cellular systems advance the multi-channel trunking by utilizing a computer to automatically search for open channels to place a user's call. Another area where the cellular telephone differs is in its ability to utilize frequency reuse in each service area. This is possible because low power transmitters and receivers are used to divide an area into cells. A set of channel frequencies is assigned to each cell, and each cell is arranged in such a way that neighboring cells are using different sets. As a result of this type of arrangement, different conversations over the same frequencies, in areas only several miles apart, are possible.

It is estimated that approximately 100 cities in the U.S. will be offering cellular radio-telephone service by 1985. With this increased availability of cellular telephone service, the number of cellular telephone subscribers is also projected to increase through 1990, as illustrated in Figure 18-1.

Figure 18-2 shows that by 1988 the U.S. will have the largest share of the cellular telephone market. This surge will be

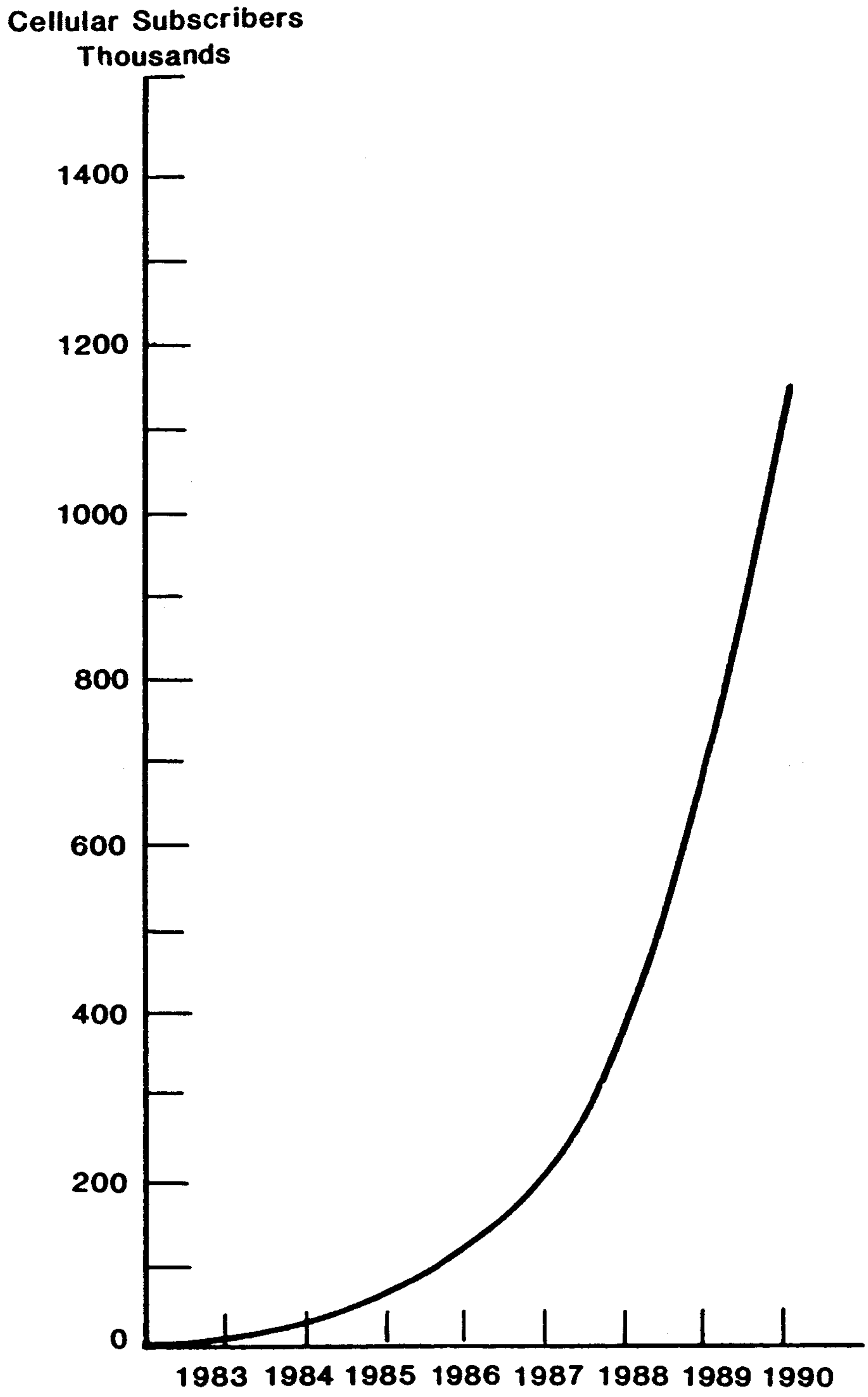


Figure 18-1. Anticipated Cellular Use in the U.S.

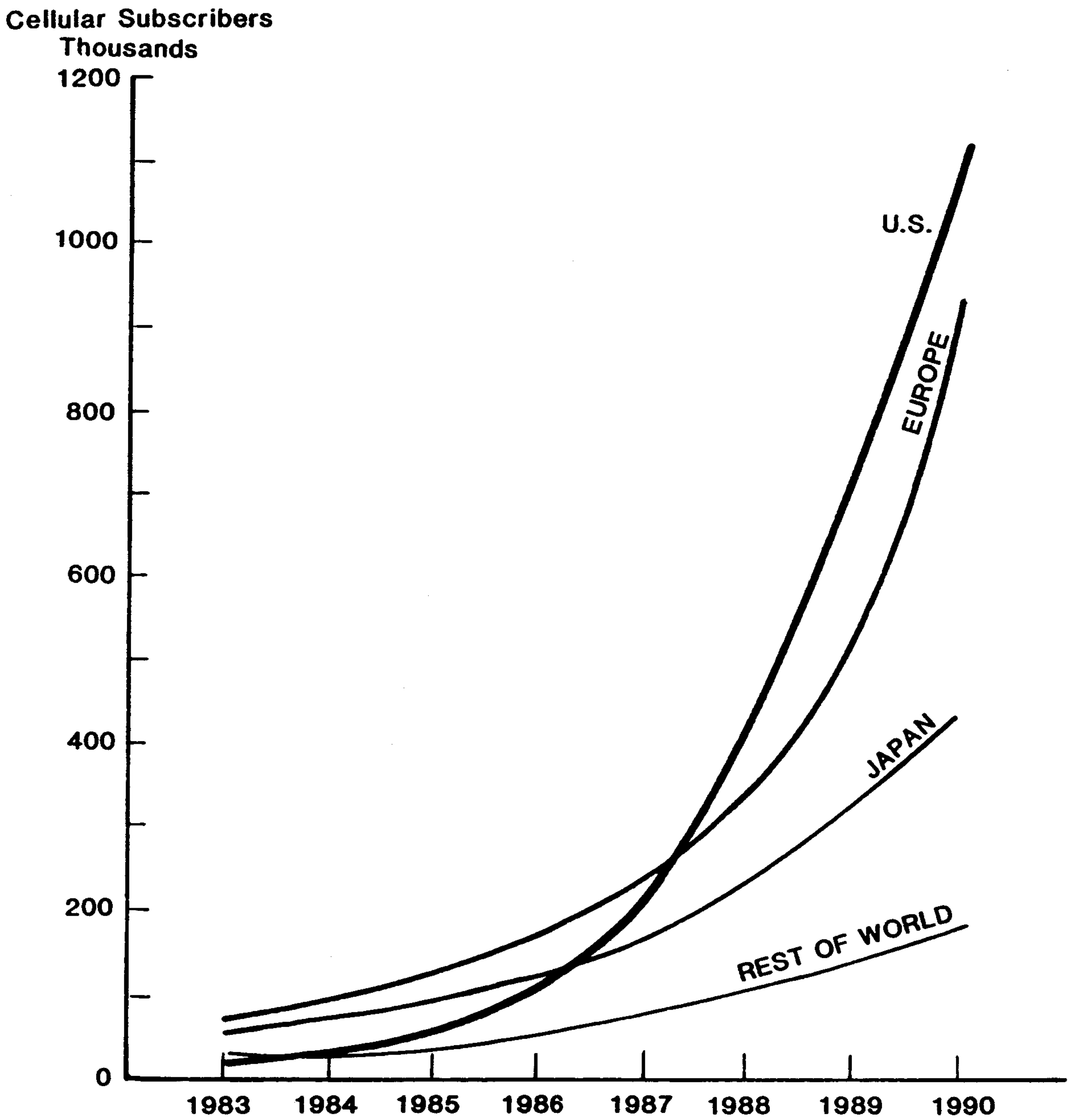


Figure 18-2. Projected Cellular Telephone Usage for the U.S. and Other Foreign Countries

the result of adequate government regulations and the wide-open competitive market in the U.S.

The frequency allocations and the equipment architectures of the cellular phone systems at present limit maximum capacity to between 5 and 10 million U.S. users. At the present time there are about 85 million telephone lines installed in the U.S.

A relatively new technology in the communication service industry is the use of electronic switching systems, which are nearly maintenance-free since they contain no moving parts. These systems offer far more speed and reliability than the older switching systems and provide new customer calling services. They have been available in some areas since 1978, but many are being replaced by second and third generations systems, which are time-division digital switches.

Electronic switching systems provide the following customer calling services: call waiting, three-way calling, call forwarding, and speed calling. Call waiting service allows a customer to answer a second incoming call while using a telephone. If a second party calls, the customer will hear a brief tone signal, while the incoming caller only hears the usual ringing signal. In order to end the first call or hold the first call while answering the second call, the customer merely presses the telephone's switchhook and is then connected with the incoming caller. Three-way calling service allows the customer to add a third person to the conversation. Call forwarding allows the customer to transfer incoming calls automatically to any other telephone in the continental U.S. that can be dialed without operator assistance. In some areas, calls may only be forwarded within the exchange area. Speed calling service allows the customer to reach frequently called numbers (up to 15 digits) by dialing only one or two digits. The service is available in 8 and 30 number lists.

Another new technology that will be introduced to the telephone industry in phases throughout the 1980s is dynamic nonhierarchical routing (DNHR). This technological routing program utilizes electronic switches and permits the choice of transmission routes to change with the time of day, without constraint by the five-level hierarchical ranking of the central switching offices. The DNHR achieves greater trunk utilization than the current hierarchical routing, thereby reducing the requirement for trunks in the network. The use of DNHR results not only in increased operational efficiency, but also improved network performance. Once DNHR becomes fully implemented, the cost savings are estimated to be 15% over the existing hierarchical routing network.

Emerging telecommunication needs require digital technology. Information services, such as remote banking, shopping and wordprocessing, begin as digital signals. Before these signals can be transported by the present voice network, the digital signals must be converted into voice-like (analog) signals. A "modem" device is used to convert customer digital signals into analog signals. Because of the increased demand for digital signal transport, the present nationwide telephone network is evolving towards what is called the Integrated Services Digital Network (ISDN), whose goal is to embody end-to-end digital connectivity. At the present time this is being achieved by the installation of increasing numbers of digital toll switchers and by bringing lightwave facilities into the toll plants. At the interexchange plant, existing digital trunks are being modernized and their capabilities are being expanded through digital electronic enhancements to existing copper loops. It is projected that by 1990, 90% of the U.S. telephone network will be digital.

Lightwave communications will easily fit into the ISDN network. The major use of lightwave communications in 1984 was for interoffice trunking. Lightwave networks have now been implemented in large metropolitan areas. These systems provide greater flexibility, improved transmission, and simplified maintenance. The South Central Bell Telephone Company offered the nation's first direct customer hookup to the fiber optic lightwave system for voice and data transmission in September of 1984. Because of the rapidly dropping costs of fiber optic cable, it is sometimes more economical to install fiber optic cable over the conventional copper cable. Once lightwave transmission is brought close to customers, copper wire pairs with electronic enhancements can be made to handle wideband signals for the short distance remaining to the customers' premises.

The ISDN will bring a number of new services and greater flexibility to the user. Some of the new services that will be available through the ISDN network are: advance calling, national number calling, and call screening. National number calling allows the customer to have a single telephone number that can reach any location within the country. For example, a business could program the network to route calls to a West Coast office after the East Coast office closed. Call screening enables a customer to limit the reception of calls only to those from designated numbers. Advance calling permits a user to instruct the local office to record a message and automatically forward it to any telephone.

The future of the communications service industry appears to rely upon the innovative technological advances within the communications equipment industry. With the introduction of fiber optics came an increased information carrying capacity which allows for not only the transmission of voice over telephone lines but also data and digital television. Theoretically, 500 million simultaneous telephone conversations can take place over a single optical fiber with a diameter of 0.005mm. This increased bandwidth will allow for not only a large number of simultaneous telephone conversations but also simultaneous data transmissions and digital television broadcasts.

In summary, the advent of fiber optic technology in the communications network will allow for the following services to become available:

- data transmission via telephone lines,
- videotex and teletext services,
- digital television transmission via telephone lines,
- telepresence,
- meter reading,
- remote sensing of fire and intruders.

B.19 "THE CONSTRUCTION INDUSTRY" (SICs 15, 16, 17)

TABLE OF CONTENTS

SOURCES: EOP/OMB:

Standard Industrial Classification Manual, 1972

U.S. DOC/BOC:

Statistical Abstract of the U.S., 1982-1984

Census of Manufactures, 1977

Annual Survey of Manufactures, 1981

U.S. DOC/BIE:

U.S. Industrial Outlook, 1984

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

B.19 "THE CONSTRUCTION INDUSTRY" (SICs 15, 16, 17)

The construction sector accounted for approximately 4.2% of the U.S. GDP in 1980. The subsectors of the construction industry are classified under SIC categories 15-17: SIC 15 includes subdivisions associated with building construction, SIC 16 with nonbuilding construction and SIC 17 with special trade contractors. Table 19-1, shows the subdivisions of each subsector and the subsector's contribution to the sector's value added in 1977.

Although these subsector groupings are convenient from the point-of-view of skills or methods of operation, they also overlap from the point-of-view of the finished product. Most of the work done by those in the subdivisions under SIC 17, the special trade contractors, will be in the construction of buildings--which also falls under SIC 15. Workers in SIC 17 may also subcontract to those in SIC 16 as, for example, if an electrician is hired to install lights in a tunnel.

Most available data on goods produced are given in terms of the overall structure produced, e.g., residential buildings and nonresidential buildings, rather than the amount of a specific item, e.g., dollars of electrical work installed. The one notable exception to this is the Bureau of the Census data, which are given by work specialty categories. However, even if these figures were made available, confusion still arises because of the overlapping of functions associated with the subsectors.

For the above reasons, we have departed from the usual SIC classification methodology and have subcategorized the construction industry into building and nonbuilding construction with further subdivisions as shown in Table 19-2. Note that the SIC classifications are retained in the case of nonbuilding construction, since, as mentioned above, this seems to be more of a self-contained category. Residential building construction and non-

TABLE 19-1

CLASSIFICATION OF SUBSECTORS
OF THE CONSTRUCTION SECTOR (SICs 15-17)
AND CONTRIBUTION TO SECTOR IN 1977

SIC CODE	SUBSECTOR AND SUBDIVISION DESIGNATIONS	% CONTRIBUTION TO SECTOR
15	**BUILDING CONSTRUCTION—GENERAL CONTRACTORS AND OPERATIVE BUILDERS**	25.0
152	GENERAL BUILDING CONTRACTORS, RESIDENTIAL BUILDINGS	
153	OPERATIVE BUILDERS	
154	GENERAL BUILDING CONTRACTORS, NONRESIDENTIAL BUILDINGS	
16	**CONSTRUCTION OTHER THAN BUILDING CONSTRUCTION—GENERAL CONTRACTORS**	26.9
161	HIGHWAY AND STREET CONSTRUCTION, EXCEPT ELEVATED HIGHWAYS	
162	HEAVY CONSTRUCTION, EXCEPT HIGHWAY AND STREET CONSTRUCTION	
17	**CONSTRUCTION—SPECIAL TRADE CONTRACTORS**	48.1
171	PLUMBING, HEATING (EXCEPT ELECTRICAL), AND AIR CONDITIONING	
172	PAINTING, PAPER HANGING, AND DECORATING	
173	ELECTRICAL WORK	
174	MASONRY, STONEWORK, TILE SETTING, AND PLASTERING	
175	CARPENTRY AND FLOORING	
176	ROOFING AND SHEET METAL WORK	
177	CONCRETE WORK	
178	WATER WELL DRILLING	
179	MISCELLANEOUS SPECIAL TRADE CONTRACTORS	

SOURCE: U.S. DOC/BOC: STATISTICAL ABSTRACT OF THE U.S., 1984
EOP/OMB: STANDARD INDUSTRIAL CLASSIFICATION MANUAL, 1972

TABLE 19-2

REVISED CONSTRUCTION CLASSIFICATION

I. BUILDING CONSTRUCTION

A. RESIDENTIAL BUILDING

1. SINGLE FAMILY DWELLINGS

2. NONSINGLE FAMILY BUILDINGS

B. NONRESIDENTIAL BUILDING

II. NONBUILDING CONSTRUCTION

A. HIGHWAY AND STREET CONSTRUCTION, EXCEPT ELEVATED HIGHWAY

B. HEAVY CONSTRUCTION, EXCEPT HIGHWAY AND STREET CONSTRUCTION residential building construction have been selected for further discussion due their dominance of the domestic construction industry.

B.19.1 Residential Building Construction

Residential building construction industry, as listed in Table 19-2, includes all single family dwellings as well as multiple family complexes. The residential building construction industry, taken as a whole, is the largest category of the construction sector, accounting for 41.2% of the construction sector's contribution to GDP in 1977.

The building construction industry (including nonresidential building construction) has a high degree of fragmentation. The 1977 Census figures for general building contractors and operative builders, plus special trade contractors, show an average of 7.5 workers per establishment (as compared with 29.3 for heavy nonbuilding construction), with 93.2% of 443,641 firms employing fewer than 20 workers each. Forty one large establishments (1,000 or more workers), employing 2.6% of the total building construction work force, produce only 2.4% of total construction receipts.

In addition to establishments with payroll, there are many independent builders who work alone or in partnership with another person. Data were not available for these independent builders for 1977, but a 1967 Census report shows that approximately 17% of construction workers in the non-heavy construction field had their own business without payroll; almost all were one-man operations. The current percentage of workers in this category is not known but is expected to be significant.

The residential building construction industry's current and historical profile is shown in Table 19-3 which portrays the industry's business and structural profiles. Table 19-3 shows

TABLE 19-3

BUSINESS AND STRUCTURAL PROFILE OF RESIDENTIAL BUILDING CONSTRUCTION

ESTABLISHMENTS (1977 EST.) (CATEGORIZED BY NO. OF EMPLOYEES)

SMALL (>20)	343,000
INTERMEDIATE (20-1000)	25,000
LARGE (<1000)	34
TOTAL	368,034

LEADING FIRMS (1982)

NAME	PERCENT INDUSTRY OUTPUT
U.S. HOME	1.1
PULTE HOME	0.6
RYAN HOME	0.5
JIM WALTER CORP.	0.4
THE RYLAND GROUP	0.3
TOTAL	2.9

NEW HOUSING UNITS STARTED (THOUSAND)	1970	1972	1975	1977	1979	1981
1 UNIT STRUCTURES	813	1309	892	1451	1194	705
2-4 UNIT STRUCTURES	85	141	64	122	122	91
5 OR MORE UNIT STRUCTURES	536	906	204	414	429	288

ESTIMATE VALUE OF NEW CONSTRUCTION (BILLION$)	1972	1977	1979	1981	1983	1984 EST.
CURRENT $	56.6	80.7	88.7	77.9	105.8	115.4
1977 $	86.7	80.7	76.0	55.9	70.2	75.2
TOTAL EMPLOYMENT (EST.) (MILLIONS)	2.34	2.49	2.85	2.68	—	—

	1980	1981	1982
NET PROFIT MARGIN AFTER TAXES, YEAR %	12.4%	8.3%	4.0%

R&D EXPENDITURES NONE

SOURCES: U.S. DOC/BOC: STATISTICAL ABSTRACT OF THE U.S., 1984
VALUE-LINE INVESTMENT SURVEY, 1984

that the estimated value of new construction has fallen from $86.7 billion in 1972 to $72.2 billion in 1984 (1977 $), an average annual drop of 1.2%. Total employment rose from 2.3 million in 1972 to 2.7 million in 1981, an average annual increase of 1.5%. Net profit margin after taxes has fallen from 12.4% in 1980 to 4.0% in 1982. The five leading firms in 1982, which combine for only 2.9% of the industry output, highlighting the degree of fragmentation found in the industry.

Among the factors which constrain the residential construction industry, interest rates are the most important. High interest rates make mortgages difficult to obtain for consumers, thereby slowing new construction. Other factors which constrain the industry are high unemployment and slow growth in disposable personal income.

Competitive Issues Affecting the Residential Construction Industry

The residential construction industry has no significant foreign competition in the U.S.

Productivity in the Residential Construction Industry

In order to ascertain the relative strength of U.S. productivity with respect to other nations, a comparison was made with Japan for the building construction industry. This comparison is presented in Tables 19-4 and 19-5 which are to be matched with Tables 19-6 and 19-7, respectively. The floor area costs are almost the same for U.S. and Japanese residential construction for these years. The floor area productivity per worker is plotted for both U.S. and Japanese building construction (both residential and nonresidential) in Figure 19-1, using the data from Tables 19-5 and 19-7. Clearly, U.S. productivity has stayed higher in absolute terms, but both countries show a downtrend.

TABLE 19-4

AVERAGE JAPANESE FLOOR AREA COSTS, BY YEAR, IN CONSTANT 1975 DOLLARS

	RESIDENTIAL				NONRESIDENTIAL				TOTAL			
YEAR	VALUE (BILLION YEN)	FLOOR AREA ($1000 m^2$)	COST (YEN/m^2)	COST[a] ($/SQ. FT.)	VALUE (BILLION YEN)	FLOOR AREA ($1000 m^2$)	COST (YEN/m^2)	COST[a] ($/SQ. FT.)	VALUE (BILLION YEN)	FLOOR AREA ($1000 M^2$)	COST (YEN/M^2)	COST[a] ($ SQ.FT.)
1970	6978	111295	62698	19.80	5929	93739	63250	19.98	12907	205034	62951	19.88
1975	9478	124912	75877	23.97	5199	71380	72836	23.01	14677	196262	74771	23.62
1978	10799	149751	72113	22.78	5945	82246	72283	22.83	16744	231997	72173	22.80
1979	10583	150618	70264	22.19	6666	94681	70405	22.24	17249	245299	70318	23.15
1980	9717	132274	73461	23.20	6480	88699	73056	23.08	16197	220973	73299	23.15
1981	9061	120085	75455	23.83	6273	82629	75918	23.98	15334	202714	75694	23.89
TOTAL/ AVERAGE	**56616**	**788935**	**71763**	**22.67**	**36492**	**513374**	**71083**	**22.45**	**93108**	**1302309**	**71495**	**22.58**

[a] USING 1975 EXCHANGE RATE OF $.0034 PER YEN

SOURCE: JAPANESE STATISTICAL YEARBOOK, 1983, PRIME MINISTER'S OFFICE

TABLE 19-5

JAPANESE PRODUCTIVITY IN FLOOR AREA/WORKER BY YEAR

YEAR	TOTAL AREA BUILT ($1000m^2$)	TOTAL CONSTRUCTION WORKERS (MILLION)	TOTAL WORKERS IN BLDG. CONSTRUCTION (MILLION)	PRODUCTIVITY (m^2/WORKER)	PRODUCTIVITY (SQ. FT./WORKER)
1970	205,034	3.94	2.84	72.20	777
1975	196,292	4.79	3.25	60.40	650
1978	231,997	5.20	3.90	59.49	640
1979	245,299	5.36	3.97	61.79	665
1980	220,973	5.48	4.29	51.51	554
1981	202,714	5.44	4.26	47.58	5121
TOTAL	**1,302,309**	**30.21**	**22.51**	**57.85**	623

USING THE PERCENTAGES FROM TABLE 19-1 TO APPORTION WORKERS TO THE BUILDING CONSTRUCTION PORTION.

SOURCES: JAPANESE STATISTICAL YEARBOOK, 1983, PRIME MINISTER'S OFFICE

TABLE 19-6

AVERAGE U.S. FLOOR AREA COSTS, BY YEAR, IN CONSTANT 1975 DOLLARS

	RESIDENTIAL			NONRESIDENTIAL			TOTAL		
YEAR	VALUE ($/BILLIONS)	FLOOR AREA (MILLION SQ. FT)	COST ($/SQ. FT.)	VALUE ($ BILLIONS)	FLOOR AREA (MILLION SQ. FT.)	COST ($/SQ. FT.)	VALUE ($/BILLIONS)	FLOOR AREA (MILLION SQ. FT.)	COST ($/SQ. FT.)
1970	39.2	1781	22.01	38.9	1157	33.62	78.1	2938	26.58
1971	54.3	2279	23.83	39.9	1156	34.52	94.2	3435	27.42
1972	65.7	2823	23.27	39.2	1260	31.11	104.9	4083	25.69
1973	59.9	2574	23.27	41.2	1439	28.63	101.1	4013	25.19
1974	37.5	1657	22.63	37.0	1282	28.86	74.5	2939	25.35
1975	31.3	1441	21.72	31.6	949	33.30	62.9	2390	26.32
1976	44.0	1867	23.57	29.9	952	31.41	73.9	2819	26.21
1977	56.9	2440	23.32	32.2	1096	29.38	89.1	3536	25.20
1978	62.4	2815	22.17	37.5	1286	29.16	99.9	4101	24.36
1979	54.3	2528	21.48	36.6	1377	26.58	90.9	3905	23.28
1980	40.5	1892	21.41	33.4	1200	27.83	73.9	3092	23.90
TOTAL/ AVERAGE	**58.16**	**25717**	**22.62**	**433.0**	**14331**	**30.21**	**1014.6**	**40048**	**25.33**

SOURCE: U.S. DOC/BOC: STATISTICAL ABSTRACT OF THE U.S., 1984

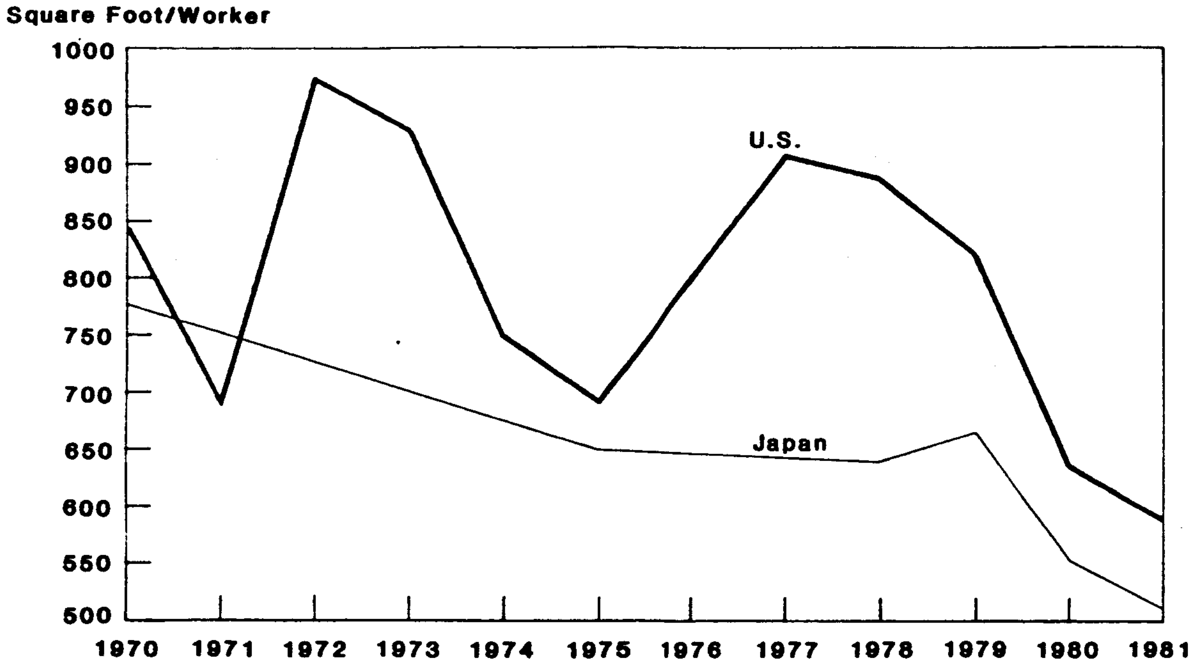
TABLE 19-7

U.S. PRODUCTIVITY IN FLOOR AREA/WORKER BY YEAR

YEAR	TOTAL AREA BUILT (SQ. FT. X 10^6)	TOTAL CONSTRUCTION WORKERS (MILLION)	TOTAL WORKERS IN BLDG. CONSTRUCTION (MILLION)[a]	PRODUCTIVITY (SQ.FT./WORKER)
1970	2938	4.818	3.479	844
1971	3437	5.003	3.762	687
1972	4082	5.279	4.197	972
1973	4013	5.562	4.322	929
1974	2938	5.517	3.928	748
1975	2390	5.093	3.458	691
1976	2819	5.255	3.542	796
1977	3536	5.612	3.900	907
1978	4101	6.166	4.625	887
1979	3905	6.437	4.763	820
1980	3092	6.215	4.866	635
1981	2797	6.060	4.751	589
TOTAL	**40048**	**67.017**	**49.593**	**808**

[a] USING THE PERCENTAGES FROM TABLE 19-1 TO APPORTION WORKERS TO THE BUILDING CONSTRUCTION PORTION

SOURCES: U.S. DOC/BOC: STATISTICAL ABSTRACT OF THE U.S., 1984
LABOR FORCE STATISTICS (OECD)



Source: Statistical Abstract of the United States, 1984,
Japanese Statistical Yearbook, 1983,
Prime Ministers Office.

Figure 19-1. Construction Productivity: U.S. Versus Japan

Table 19-8 shows dollar productivity for the subcategories listed in Table 19-2. The data which were used to compute the GDP numbers in Table 19-3 were taken from the total receipts data of U.S. establishments with payroll supplied by the Bureau of the Census. Since the classification system being used is not the SIC system, it was necessary to apportion figures for the special trade contractors to the subclasses of building construction defined in SIC 15. This was done in proportion to the activity in each subdivision of SIC 15. Slightly different proportions of construction GDP can be obtained by using in-place construction figures instead of total receipt figures; however, these differences may be due to the many independent builders who are not counted in the Census listings. In any event, the relative significance of the various subclasses of Table 19-8 would remain in the same order, in terms of information of most significance from the GDP figures.

Labor productivity for the residential construction industry in 1977 (1977 $) was $10,800 per employee ranking it last among the three construction subsectors. Labor productivity declined at an average annual rate of -2.94% for single family dwelling and -1.44% for nonsingle family dwellings from 1972 to 1977.

The residential construction industry is labor intensive, both in absolute terms and relative to its various subsectors. Depreciable capital assests averaged less than $6,000 per worker in 1977, while total capital expenditures other than land were about $800 to $900 per worker. Rental payments for rented equipment amounted to less than $300 per worker.

Technological issues will be discussed along with nonresidential building construction due to their similarities.

B.19.2 NONRESIDENTIAL BUILDING CONSTRUCTION

The nonresidential building construction industry, as listed in Table 19-2, includes the construction of industrial buildings, warehouses, commercial buildings, institutional buildings, religious buildings, and recreational buildings. The nonresidential building construction category is the second largest in terms of dollar output, accounting for 36.2% of the construction sector's contribution to GDP in 1977.

The industry's historical and current posture is summarized in Table 19-9, which portrays the industry's business and structural profiles. Table 19-9 shows that the estimated value of new construction has risen from $60.9 billion in 1972 (1977 $) to $64.1 billion in 1984 (1977 $), an average annual increase of 0.4%. The total number of establishments in 1977 was 76,000 with 93% employing less than 20 persons. Construction contracts by class were dominated by commercial construction with $28 billion (47% of the total) in contracts during 1982. Manufacturing and educational structures were next with $9.3 billion (16%) and $6.1 billion (10%), respectively.

High interest rates constrain the nonresidential building construction industry due to the inability to fund projects. Other factors which constrain the industry are unemployment and slow market growth.

Competitive Issues Affecting the Nonresidential Building Construction Industry

There is no foreign competition in the nonresidential building construction industry.

Productivity in the Nonresidential Building Construction Industry

In order to ascertain the relative strength of the U.S. productivity in the nonresidential building construction industry, a comparison was made with Japan. This comparison is presented in Tables 19-4 and 19-5 which are to be matched with

TABLE 19-8

1977 PROFILE OF U.S. CONSTRUCTION FOR ESTABLISHMENTS
WITH PAYROLL VALUES IN 1977 DOLLARS

	ALL CONSTRUCTION	SINGLE FAMILY DWELLINGS	NONSINGLE FAMILY DWELLING	NONRESIDENTIAL BUILDING	NONBUILDING CONSTRUCTION HIGHWAYS & STREETS	NONBUILDING CONSTRUCTION OTHER
PERCENT OF CONSTRUCTION GDP	100.0	37.2	4.0	36.2	7.1	15.6
PRODUCTIVITY (VALUE ADDED/ WKR)	23,173	20,843	20,834	22,528	28,511	29,171
PRODUCTIVITY ANNUAL DECLINE (1972-1977) (%)	-2.24	-2.94	-1.44	-2.93	-2.94	-0.39

SOURCES: U.S. DOC/BOC: STATISTICAL ABSTRACT OF THE U.S., 1984

TABLE 19-9

BUSINESS AND STRUCTURAL PROFILE OF THE NONRESIDENTIAL BUILDING CONSTRUCTION INDUSTRY

ESTIMATED VALUE OF NEW CONSTRUCTION	1972	1977	1979	1981	1983	1984 EST.
CURRENT $	43.5	54.5	76.3	92.8	98.9	98.4
1977 $	60.9	54.5	65.4	66.6	65.7	64.1

ESTABLISHMENTS (1977 EST.) (CATEGORIZED BY NO. OF EMPLOYEES)

SMALL (>20)	70,800
INTERMEDIATE (20-1000)	5,200
LARGE (<1000)	7
TOTAL	76,000

CONSTRUCTION CONTRACTS BY CLASS VALUE OF CONSTRUCTION (BILLION $)

	1977	1979	1981	1982
TOTAL	33.1	30.2	60.1	59.02
COMMERCIAL	13.6	24.4	31.7	28.0
MANUFACTURING	5.4	7.6	8.6	9.3
EDUCATIONAL	5.2	6.3	5.8	6.1
HOSPITAL	4.5	4.8	6.4	7.9
PUBLIC BUILDINGS	2.3	1.6	1.4	1.9
RELIGIOUS	1.0	1.6	1.4	1.9
SOCIAL AND RECREATIONAL	3.3	4.9	1.2	1.3

SOURCE: U.S. DOC/BOC: STATISTICAL ABSTRACT OF THE U.S., 1984

Tables 19-6 and 19-7 respectively. The floor area costs are 30 to 35% higher from 1970 to 1981 for the U.S. This may be due to a higher standard of quality demanded in U.S. nonresidential buildings.

Table 19-8 shows productivity for the subcategories listed in Table 19-2 (see previous section for explanation of data). Labor productivity in 1977 for this industry was $22,580 per employee (1977 $), ranking this subsector higher than residential building construction, but not as high as nonbuilding construction, where value added per worker averaged over $28,000 (1977 $) in 1977. During the period from 1972 to 1977, labor productivity fell at an annual rate of 2.9% per year, making this subsector similar to residential construction.

This subsector is also labor intensive, with depreciable capital assets in 1977 of $5,000 to $6,000 per employee and total capital expenditures other than land of about $1,000 per worker. Rental payments for equipment were about $600 per employee.

Role of Technology in Residential and Nonresidential Building Industry

In order to determine which areas of the construction industry offer potential savings through technology, let us first list the major activities required to construct a building. These are:

- planning and designing the building,
- procurement of materials and moving them to the building site,
- ground preparation and clearing,

- construction of roads, sewers, parking lots, etc. external to the building,

- construction of building foundation and outer shell,

- installation of utilities, including electric, plumbing, heating and air conditioning,

- construction of the ordinary building interior including carpentry, plastering and drywall,

- construction of special interior items for industrial and commercial buildings.

Each of these items has a purchasing cost, interest charges to buy the material and pay labor during construction, and general overhead and administrative costs. Taken as a whole, these are the costs associated with the construction of a building.

We may eliminate some of these as candidates for reduction through technological advances. For example, general overhead and administrative costs are more dependent on good business practices than technology. Special interior items are, by definition, not sufficiently prevalent to merit a new technology for each. Interest charges are dependent on prevailing interest rates and in that regard are not controllable. However, interest charges are also dependent on the time it takes to complete construction, which may be reduced by better schedule planning, better methods of putting things together, etc.

Cost reductions are possible through two general mechanisms: 1) better planning, engineering design, and construction coordination; 2) better or cheaper materials and structures, or those that are easier to work with, quicker to install, etc.

Better Planning, Design, Coordination--This cost saving device applies mainly to nonresidential construction, which was shown in Table 19-3 to account for about 36% of construction GDP, and to nonsingle-family residential construction of large buildings, i.e., high-rise apartments. Single-family construction generally does not involve a great deal of engineering, although builders may profit from better schedule coordination, as discussed below. However, single-family construction is usually a more standardized process.

Expenses can be reduced in several ways through better design and coordination of construction. These are as follows:

- Buildings were often "overdesigned" in the past; when last minute changes were made, the building could not be redesigned optimally. Money would be saved if building designs were amenable to such unexpected construction changes.

- The amount of material required for a job can be reduced when an approach for extracting the proper amount (i.e., specific lengths of wood, pipe, etc.) from stock-size items has been determined in advance. Rough estimates of required materials have often been made, allowing a high percentage of overage so as not to run short; and less than optimal ways to cut material were often used. An exacting approach toward preserving required material will save money.

- Crews of workers may be scheduled more efficiently so that idle time is minimized while waiting for necessary prior tasks to be finished. This will allow for more productivity per worker and a faster completion time.

- Buildings may have better structural engineering designs, requiring less material to provide an equal amount of strength against natural forces such as winds and earth tremors.

- Buildings may be designed to take advantage of natural resources, such as solar power for heating. This will increase the overall market value of the building.

The first three items depend to a large extent on computerization for their implementation. Computer-assisted design (CAD) allows an engineer to reoptimize designs quickly when small changes are made, to plan how to order and cut materials and how to schedule workers. In addition, the use of the computer saves the engineer's time, thereby lowering labor costs for design itself.

Structural engineering improvement is also being assisted by computer programs to calculate stresses in new configurations. Use of natural resources such as solar energy will depend on new technologies.

It is difficult to estimate how much can be saved by using better design and coordination. Some savings have certainly been achieved already by the use of existing CAD programs. However, since design and coordination apply to nonresidential construction as a whole, small percentage savings could be significant.

Better Materials and Structures--Material and labor are closely intertwined; changes in one may be offset by cost changes in the other. For example, while a prefabricated roof truss for a house costs more than the individual pieces of wood, it saves on the amount of labor that would have been needed to put the pieces together. Therefore, "materials" are those that are essentially unfabricated (boards, bricks, stones, etc.) as well as those that are partially fabricated (roof trusses) or even fully fabricated (plumbing fixtures, whole houses, etc.).

Thus, labor and material costs are best examined from the point of view of functions performed, as indicated by the categories listed at the beginning of this Section. Table 19-7 lists the percent of contribution to total building construction GDP by special trade contractors. This seems to be the best data available for estimating fraction of construction GDP attributable to each part of the construction process, although it has the drawback stated previously that the work of the special trade contractors may be duplicated by general contractors.

Table 19-10 indicates that the greatest contribution to building GDP is from plumbing, at 16.6%. However, while this number from the first column represents the contribution according to strict SIC subdivisions, there may be general contractors who also do plumbing work, in which case the figure would be higher. Generally, probably the best estimate of percent building GDP is somewhere between 16.6% and 28.7%, with a tendency to be closer to the higher end.

If we make the assumption that the contributions to building GDP are of the same relative order as the contributions to special trade GDP shown in Table 19-10, then the greatest contributors are plumbing, heating and air conditioning, followed by electrical, then by roofing and plastering with lower amounts. The other trades contribute almost equally in much smaller individual amounts.

There are several ways in which the cost of labor and/or materials could be reduced:

- Produce the same, or substitute, materials at a lower price per equivalent unit. This has been done, for example, in the electrical industry by substituting aluminum wire for copper wire, since aluminum is much cheaper per equivalent unit.

TABLE 19-10

SPECIAL TRADE AND GENERAL BUILDING AS A PERCENT OF BUILDING GDP AND SPECIAL TRADE GDP

SIC DESCRIPTION	% OF BUILDING TRADE GDP	% OF SPECIAL TRADE GDP
GENERAL BUILDING CONTRACTORS	41.9	----
PLUMBING, HEATING, AIR CONDITIONING	16.6	28.7
ELECTRICAL	12.1	20.8
ROOFING, SHEET METAL WORK	5.2	8.9
PLASTERING, INSULATION	5.1	8.7
CONCRETE WORK	3.4	5.8
EXCAVATION	3.4	5.8
MASONRY	3.2	5.5
CARPENTRY	2.9	5.0
PAINTING, PAPERING	2.7	4.6
OTHER	3.6	6.2

SOURCE: U.S. DOC/BOC: STATISTICAL ABSTRACT OF THE U.S., 1984

- Produce materials that are easier to work with at roughly the same price, thereby saving man-hours for installation. Plastic plumbing pipes and fittings, for example, are easier to install than copper.

- Prefabricate portions of the system to be installed. As mentioned, this has been done for the supporting members for roofs.

- Some combination of the above. For instance, work has been done on developing plastic roofing material which comes in large pieces and can be installed with little labor.

It is generally more beneficial to aim at reducing the costs of materials rather than the costs of labor, other things being equal. Table 19-11 shows that materials costs have risen at a rate of 8.15% per year, on the average, from 1970 to 1982, while labor costs have only risen on average by 7.23% per year. Therefore, cutting materials costs would seem to be more productive if these trends continue. In particular, since roofing materials have risen at the highest rate, with steel products and insulation closely following, these products would seem to be fertile ground for cost-cutting measures.

New Technologies in the Residential and Nonresidential Building Industry

As mentioned in the last section, much of the work in planning, design and coordination is related to advances in the computer industry, evidenced by computer-aided design and computer-aided manufacturing (CAD/CAM), as well as standard business control programs (accounting and payroll, inventory control, etc.). Programs may also be considered from the point of view of various participants in the construction process: the owner/investor, the financing organization, the general contrac-

TABLE 19-11

RATE OF PRICE INDEX INCREASES FOR CONSTRUCTION MATERIALS AND LABOR

ITEM	AVERAGE RISE PER YEAR IN PRICE INDEX, 1970 TO 1982 (%)
ALL MATERIALS	**8.15**
ASPHALT ROOFING	11.96
FINISHED STEEL PRODUCTS, STRUCTURAL SHAPES	11.13[a]
BLACK PIPE, CARBON	11.64[a]
WIRE NAILS, 8D COMMON	10.13
REINFORCING BARS	8.68[a]
INSULATION MATERIALS	9.26
CONCRETE INGREDIENTS	8.81
CONCRETE PRODUCTS	8.47
METAL DOORS, SASH, TRIM	8.19
GYPSUM PRODUCTS	8.18
PLUMBING FIXTURES	7.96
SOFTWOOD LUMBER, DOUGLAS FIR	7.75
SOUTHERN PINE	7.91
MILLWORK	7.60
STRUCTURAL CLAY PRODUCTS	7.47
BUILDING PAPER AND BOARD	7.46
PREPARED PAINT	7.33
HARDWOOD LUMBER	7.15
HEATING EQUIPMENT	6.56
PLYWOOD	6.55
NONFERROUS METAL PRODUCTS	6.44
BUILDING WIRE	1.38[b]

[a] UNION HOURLY WAGE RATE INCREASE FOR PERIOD 1970-1981
[b] UNION HOURLY WAGE RATE INCREASE FOR PERIOD 1970-1980

SOURCE: U.S. DOC/BOC: STATISTICAL ABSTRACT OF THE U.S., 1984

tor, subcontractors, and the users of the finished product, if different from the owner. Programs which have been developed, are being developed, or are considered good candidates for development are described below. The ideal or goal to be achieved in the future is an integration of these programs into an overall program for the purposes of optimization and coordination of planning, design, and actual construction. In this way costs can be reduced most effectively.

- Financial planning packages for the investor or financial organization. Such packages exist at the present time but are generally unsophisticated. A goal for the future would be programs that manage investments from many points of view rather than simply keeping track of a set of numbers for fixed types of situations. In this regard, time-stepped models or expert systems might be of use.

- General accounting, payroll, inventory programs, etc. These programs currently exist in fairly satisfactory forms for straightforward applications.

- Automatic representation programs. Some programs exist for automatically drawing plans, but these are generally inadequate from the viewpoint of what might be done. The computer package of the future should be able not only to draw two-dimensional plans for all aspects of a construction project but should be capable of converting plans into a three-dimensional representation shown on a monitor screen or printed in hard copy, rotated through any desired angle, and blown up to show any desired details. In this way, a project could be looked at from any position and a program could also compute dimensions and tolerances between any desired points. Such representations should be possible both for a project as a whole and for component parts of it. As a more advanced feature, computer programs that could also simulate the movement of parts on equipment and determine which pieces would "fit" if a given schedule of completing the construction would be chosen.

- Analysis of physical quantities arising from the use of a given design, such as stresses, electrical current flows in normal use and during peak conditions, water pressure and flows in sprinkler systems, etc. Such programs now exist for certain systems and may be useful in analyzing existing designs, but are not generally useful for innovation in producing new configurations.

- Production or fabrication programs, which take into account any existing design, and compute how much of each material is needed, at what cost, and how pieces of stock should be used and cut to accomplish such a design. Such programs exist for some applications (e.g., sprinkler systems) but not for others.

- Programs which combine the above features, so that different designs can be considered, analyzed, and priced for the different systems in a building (electrical, plumbing, etc.), can be tested for their workability, can be drawn and represented three-dimensionally, and can be used to determine overall cost and inventory. These programs would likely contain "expert system" components for choosing different types and combinations of designs. These expert systems might contain modules to be applied to specialized design, such as a building which could accommodate handicapped persons to a greater degree.

- Robotics programs in conjunction with robotics machinery, to fabricate in a shop portions of structures prior to being taken to the construction site. Some numerically controlled machines now exist, but nothing of an integrated nature which would take a data stream of various types of needed parts and arrange schedules and operations in a complex fashion.

- Programs to compute user needs such as space requirements, furnishings, layout, etc. Nothing is currently known of such programs.

There are two main obstacles to the development of a general construction package at the present time. The first is a lack of an overall database for writing such programs, because of the fragmentation in the building industries. The second is the lack of uniformity and consistancy in local building codes and regulations, which control the overall design and plan of any project.

There have been other design innovations in the general area of engineering design; some of these are presented below, as taken from the recent National Bureau of Standards Publication, Office Structures and Enclosures: Directions in Innovative Technology (NBS-GCR-83-434). Of course, it is hard to generalize with respect to such work in order to predict the future; each new idea is basically an isolated solution.

- Stiffness of high-rise buildings has been improved without excessive use of material by: a) the use of frame and shear truss in combination; b) the use of outrigger truss or tie-down truss; c) the use of steel-plate shear walls.

- Buildings can be made which are convertible to many different uses without complete rebuilding by the use of: a) megaframes which support "blocks" of floors constructed independently; b) hollow, tubular structures with suspended or cantilevered floors which can be changed or removed; c) vertical structural shafts with giant girders between them to support floors or blocks of floors; d) highrise, curved concrete walls, vertical folded plate, channel or fluted shape in concrete, and stable floor supports.

- Structural damping of sway in very high buildings can be accomplished by the use of tuned mass damper (TMD) and viscoelastic material.

- Wind resistance can be decreased, thereby reducing the need for more material, by the use of: a) aerodynamically efficient building forms; b) surface patterns to create beneficial turbulence; c) discharge of air from leeward surface of building.

- Seismic damage can be avoided by: a) the use of a welded moment-resisting rigid steel frame composed of a Y-shaped box column welded to three-foot deep girders weighing 28 pounds/sq.ft. of framed area; b) reinforcing "soft stories" by adding columns and/or bracing at critical floors; c) providing a shock-absorbing soft story.

- The failure of steel structural elements due to fire can be reduced by filling hollow steel trusses with water.

- Complex mechanical and communication utilities and services can be facilitated by: a) using interstitial space between floors; b) placing service shafts and ducts outside the perimeter of floor space.

- A completely open, column-free building interior can be provided for one-story buildings by: a) the placing of trusses outside a building envelope; b) the use of exterior posts and suspension cables; c) the use of self-supporting stretched fabric roof; d) use of a lightweight tubular metal dome or metal arch structure; e) the use of a prestressed cable roof; f) the use of cables and rods as tension cords of large-span trusses.

The development of electrical and plumbing fixtures which reduce cost and/or facilitate installation have already been discussed. Some other innovations which are now in existence or available in the near-future are the following:

- A continuous elastic, single-ply roofing membrane that can be laid without the application of heat, allowing a simpler installation and the use of cheaper foam material for insulation.

- Various solar heat and energy collectors, such as: a) flexible black heat absorber mats extruded from highly durable synthetic elastomers (EPDM) in lengths up to 600 feet; b) solar photovoltaic systems (now being marketed); c) finned aluminum absorber components to draw heat from the ambient air with the help of heat pumps; d) windmill electricity generators.

- Various inorganic cellular material for different uses, such as: a) cellular or foamed glass for use as insulation against heat exchange and water transfer; b) cellular or aerated concrete for use as wall material for load-bearing, low rise structures; c) "foamed" ceramic bricks and blocks having reduced weight.

- Prefabricated products, such as prefabricated brick walls for use as outer shell or as complete, insulated wall and prefabricated facade in architectural concrete.

- New glasses and windows, such as: a) a new glass type to prevent fire from promulgating through glass; b) tinted, heat absorbing, and reflective glasses for optimal thermal/optical performances; c) windows with rolling external shade to prevent heat transfer at night when building is not in use.

As stated in the previous sections, these new materials can reduce overall cost by being cheaper in themselves or by lessening the amount of labor required for their installation. They may also, of course, add to the overall value of the structure because they are of better quality than the old materials.

Roofing was cited as a high cost item, and the new elastic roofing described above is a step toward improving costs, both by cutting down on labor for installation and by being cheaper per unit area, as production methods improve.

Basic prospects for technological cost reduction are in the manufacture or growth of the raw material and in the prefabrication of various structures. Imagination may be helpful in this regard. For example, if wood could be grown faster, by some new biological process, then this would increase forest productivity and reduce costs. New methods of processing iron would, of course, contribute to savings in building industrial, commercial, and high-rise structures.

Prefabrication of electrical wiring could be done, perhaps, by making an electrical distribution system to be placed in the attic or basement of houses, similar to a printed circuit board. Wiring would then be run vertically only to this central connection. More complex systems of this nature might be put into high-rise buildings or other nonresidential buildings.

Better prefabrication methods could be developed for structural members or entire buildings. Wall frames might be cast of a plastic material rather than made of wood nailed together, if this were economical; or wood might simply be precut if tolerances could be determined accurately.

The field of solar energy offers opportunities for improvements in the types of devices used to collect energy; however, this area is clearly in the developmental stage. Some of the products listed above suggest ideas for future technological advances.

B.19.3 CONCLUSION

The residential and nonresidential construction industry in the U.S. is saturated. Value of new construction combined for both fell from $147.6 billion in 1972 (1977 $) to $136.3 billion in 1984, an average annual decrease of 0.7%. Productivity in the U.S. shows a downtrend in recent years. This is due in part to the periods of recession experienced during the past 12 years. The dominant constraint affecting the industry is high interest rates. These interest rates partially depend on the amount of time needed to complete construction.

Future technology thrusts should be aimed at improving computer-aided design systems (CAD) and at the development and use of advanced materials in the construction industry. Both of these thrusts would have a significant impact on productivity. Refer to Section E.3 for discussion of AI (Artificial Intelligence) which will impact CAD. Refer to Section E.1 for discussion of Advanced Materials.

B.20 "MINING" (SICs 10, 11, 12, 13, 14)

TABLE OF CONTENTS

SOURCES: U.S. DOC/BOC:

Statistical Abstract of the U.S., 1984

Census of Mineral Industries, 1977

U.S. DOL/BLS

U.S. DOE/EIA

EOP/OMB:

Standard Industrial Classification Manual, 1972

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF TABLES (Continued)

LIST OF FIGURES

B.20 "MINING" (SICs 10, 11, 12, 13, 14)

The mining subsectors, SICs 10-14, include all establishments engaged in the extraction of naturally occurring minerals from the ground, such as coal, ores, crude petroleum, and natural gas. Activities such as quarrying, well operation, milling, and other mine site preparations, as well as exploration and development, are included within these subsectors. Table 20-1 lists the mining subsectors and their contribution to the sector in 1977.

The mining sector contributed 1.5% to the GNP in 1980. The subsectors are characterized by:

- A high degree of fragmentation. Out of a total of approximately 31,400 establishments, 24,700 employed less than 20 persons (1977).
- A labor productivity of $60,795 per employee/year or $31.66 per employee hour (1977, 1972 $). The compound annual labor productivity growth rate was 6.4% from 1972 to 1977.
- Capital expenditures which amounted to $15,838 per employee (1977, 1972 $).
- R&D expenditures of $803 million in 1978.

The subsectors are clearly categorized in terms of principal minerals produced. At the three digit subdivision level, however, some redundancy is apparent. For example, subdivision 108 includes metal mining services, such as boring, draining, drilling, exploration, the removal of overburden, and even the contractual operation with the particular product produced. Data derived from the service subdivisions (SICs 108, 138, and 148) will therefore be therefore examined in connection with the two digit subsectors which categorize the same end product.

TABLE 20-1

CLASSIFICATION OF SUBDIVISIONS
OF THE MINING SUBSECTORS (SICs 10-14)
WITH 1977 CONTRIBUTIONS TO SECTOR

SIC CODE	SUBSECTOR AND SUBDIVISION DESIGNATIONS	% CONTRIBUTION
10	**METAL MINING**	6.0
101	IRON ORES	
102	COPPER ORES	
103	LEAD AND ZINC ORES	
104	GOLD AND SILVER ORES	
105	BAUXITE AND ALUMINUM ORES	
106	FERROALLOY ORES (EXCEPT VANADIUM)	
108	METAL MINING SERVICES	
109	MISCELLANEOUS METAL ORES	
11	**ANTHRACITE MINING**	6.2
111	ANTHRACITE MINING	
12	**BITUMINOUS COAL AND LIGNITE MINING**	18.7
121	BITUMINOUS COAL AND LIGNITE MINING	
13	**OIL AND GAS EXTRACTION**	60.3
131	CRUDE PETROLEUM AND NATURAL GAS	
132	NATURAL GAS LIQUIDS	
138	OIL AND GAS FIELD SERVICES	
14	**MINING AND QUARRYING OF NONMETALLIC MINERALS EXCEPT FUELS**	8.8
141	DIMENSION STONE	
142	CRUSHED AND BROKEN STONE, INCLUDING REPROP	
144	SAND AND GRAVEL	
145	CLAY, CERAMICS, AND REFRACTORY MINERALS	
147	CHEMICAL AND FERTILIZER MINERAL MINING	
148	NONMETALLIC MINERALS SERVICES (EXCEPT FUELS)	
149	MISCELLANEOUS NONMETALLIC MINERALS, EXCEPT FUELS	

SOURCE: U.S. DOC/BOC: STATISTICAL ABSTRACT OF THE U.S., 1984
EOP/OMB STANDARD INDUSTRIAL CLASSIFICATION MANUAL, 1972

Mineral fuels are the greatest contributor to mining output, of which petroleum products occupy a considerable portion, see Tables 20-2 and 20-3. The total value of mineral fuels extracted, when measured in dollars, represents an ever increasing fraction over time of the total mining extraction value. In 1981 (the latest year for which figures are available), mineral fuels represented 86.6% of the total value. Almost all of the dollar increase in the value of mineral fuels since 1970 has occurred in crude petroleum and natural gas, with coal extraction remaining about the same overall.

It is reasonable to attribute much of this increased mineral fuel value to the rising price of fuels. Table 20-4 shows no significant increase in the actual extraction of either crude petroleum or coal; and, the production of other minerals, listed in Table 20-2, has not experienced a significant downward trend.

Table 20-5 shows the labor and capital expenditures (1977) for various mining categories. Bituminous coal mining had the highest labor cost with $22,800 per employee, while petroleum mining had the highest capital per worker ratio with $37,500 per employee. Table 20-6 lists value added per worker for these mining categories in 1977. Natural gas and petroleum had the highest value added per employee, with $252,800 and $134,700 respectively.

The remainder of this analysis will concentrate on profiling mineral fuel extraction for crude petroleum and natural gas production (SIC 131), which represents approximately two-thirds of mining output, by dollar value in recent years; and coal mining (SICs 11 and 12), a homogeneous industry that is second in value of total output.

B.20.1 CRUDE PETROLEUM AND NATURAL GAS (SIC 131)

The crude petroleum and natural gas subdivision (SIC 131) is involved in the exploration, drilling, and equipping of wells;

TABLE 20-2

PERCENT OF TOTAL MINING PRODUCTION ATTRIBUTABLE TO VARIOUS PRODUCTS, BY YEAR

CATEGORY	PERCENT OF TOTAL DOLLAR VALUE							
	1970	1975	1977	1978	1979	1980	1981	AVG
ALL MINERAL FUELS	**66.3**	**75.8**	**76.8**	**75.9**	**77.6**	**82.9**	**86.6**	**77.6**
PETROLEUM (CRUDE)	39.4	39.1	35.3	34.8	36.9	46.1	52.9	40.6
NATURAL GAS (WET)	13.1	15.1	21.7	22.1	22.6	22.0	21.3	19.7
COAL (BITUMINOUS & LIGNITE)	13.3	20.8	18.8	17.7	17.2	13.7	11.5	16.1
ALL NONMETALLIC MINERALS EXCEPT FUELS	**20.4**	**16.0**	**16.0**	**16.5**	**14.4**	**11.0**	**8.7**	**14.7**
CEMENT	4.7	3.6	4.0	4.2	3.4	2.6	2.0	3.5
STONE	5.2	3.5	3.4	3.5	3.2	2.3	1.7	3.3
SAND AND GRAVEL	3.9	2.4	2.8	2.8	2.3	1.6	1.2	2.4
PHOSPHATE ROCK	0.7	1.9	1.1	1.1	1.0	0.9	0.8	1.1
LIME	1.0	0.9	0.9	0.9	0.8	0.6	0.5	0.8
CLAYS	0.9	0.7	0.8	0.9	0.8	0.6	0.5	7.4
SALT (COMMON)	1.1	0.6	0.6	0.6	0.5	0.4	0.3	5.9
SULFUR: FRASCH MINES	0.5	0.5	0.4	0.3	0.4	0.5	0.4	4.3
ALL METALS	**13.3**	**8.2**	**7.2**	**7.7**	**8.0**	**6.1**	**4.7**	**7.9**
COPPER	7.0	3.0	2.7	2.4	2.8	1.8	1.5	3.0
IRON ORE, USABLE	3.3	2.7	1.9	2.9	2.6	1.7	1.6	2.4
MOLYBDENUM	0.7	0.4	0.4	0.7	0.8	0.9	0.5	0.6
SILVER	0.3	0.3	0.2	0.3	0.4	0.5	0.2	0.3
GOLD	0.2	0.3	0.2	0.2	0.3	0.4	0.3	0.3

SOURCE: U.S. DOC/BOC: STATISTICAL ABSTRACT OF THE U.S., 1984

TABLE 20-3

PERCENT OF TOTAL MINING VALUE ADDED ATTRIBUTABLE TO VARIOUS PRODUCTS, BY YEAR

CATEGORY	PERCENT OF TOTAL VALUE ADDED				
	1958	1963	1967	1972	1977
OIL AND GAS EXTRACTION	67.5	69.2	69.3	66.5	71.4
COAL MINING	13.3	10.9	10.8	14.2	16.6
NONMETALLIC MINERALS MINING	10.4	11.0	11.8	10.3	6.8
METAL MINING	8.8	8.9	8.1	9.0	5.2

SOURCE: U.S. DOC/BOC: STATISTICAL ABSTRACT OF THE U.S., 1984

TABLE 20-4

MINERAL FUEL PRODUCTION, 1970 TO 1981

MINERAL	UNIT	PRODUCTION QUANTITY					
		1970	1975	1977	1979	1980	1981
COAL							
BITUMINOUS	MILLION SHORT TONS	603	648	691	776	824	818
ANTHRACITE	MILLION SHORT TONS	10	6	6	5	6	5
NATURAL GAS (WET)	TRILLION CUBIC FT.	22	20	20	21	20	20
PETROLEUM (CRUDE)	MILLION BBL	3,517	3,057	3,009	3,121	3,146	3,129
URANIUM	MILLION LBS.	23.1	23.2	29.9	37.5	43.7	38.5

SOURCE: U.S. DOC/BOC: STATISTICAL ABSTRACT OF THE U.S., 1984

TABLE 20-5

EXPENDITURES FOR LABOR AND CAPITAL ITEMS (OTHER THAN LAND AND MINERAL RIGHTS) FOR VARIOUS MINING CATEGORIES (1977)

SIC CODE	CATEGORY	LABOR COSTS ($1,000/WORKER)	CAPITAL EXPENDITURES ($1,000/WORKER)
10	METAL MINING	21.1	13.0
11	ANTHRACITE MINING	18.6	2.7
12	BITUMINOUS MINING	22.8	11.6
11 & 12	COAL MINING	22.7	11.5
131 & 138	PETROLEUM MINING	19.0	37.5
132	NATURAL GAS LIQUIDS	21.4	25.3
14	NONMETALLIC MINING	16.1	6.9

SOURCE: U.S. DOC/BOC: CENSUS OF MINERAL INDUSTRIES, 1977

TABLE 20-6

VALUE ADDED PER WORKER FOR VARIOUS MINING SUBSECTORS (1977)

SIC CODE	SUBSECTOR	VALUE ADDED PER WORKER ($1,000 DOLLARS)
10	METAL MINING	40.0
11	ANTHRACITE MINING	34.2
12	BITUMINOUS MINING	46.1
11 & 12	COAL MINING	45.9
131 & 138	PETROLEUM MINING	134.7
132	NATURAL GAS LIQUIDS	252.8
14	NONMETALLIC MINING	39.8

SOURCE: U.S. DOC/BOC: CENSUS OF MINERAL INDUSTRIES, 1977 the operation of emulsion breakers, separators, and desilting equipment; and, all other activities associated with the preparation of oil and gas up to the point-of-shipment from the producing property.

The subdivision's historical and current posture is summarized in Tables 20-7 and 20-8, which portray the industry's business and structural profiles, respectively. Table 20-7 shows that industry shipments have decreased at a compound annual rate of 1.0% in eleven years, from $15.7 billion in 1972 to $14.1 billion in 1983 (1972 $). Employment has risen at a compound annual rate of 5% in eleven years, from 116,600 in 1972 to 199,900 in 1983. The U.S. share of world crude oil production has fallen from 34% in 1960 to 15% in 1981, while the share of natural gas production has fallen from 75% in 1960 to 35% in 1981.

Table 20-8 shows that the crude oil and natural gas industry is dominated by seven firms (sometimes referred to as the "seven sisters"). Of the 17,775 establishments, 14,836 are small (less than 20 employees), 2,896 are intermediate (20 to 1000 employees), and 23 large (greater than 1000 employees). Consumption of petroleum in the U.S. has fallen from 6.0 billion barrels in 1972 to 5.5 billion barrels in 1983. Consumption of natural gas has fallen from 22.1 trillion cubic feet in 1972 to 17.0 trillion cubic feet in 1983.

U.S. petroleum consumption increased 50% between 1960 and 1970 in conjunction with steady economic growth. However, the increased use of Middle East oil during this period resulted in little effort to develop new supplies; domestic consumption outpaced domestic production and reserves.

Significant structural changes have occurred in the crude oil and natural gas industry since 1972. The 1973-74 OPEC (Organization of Petroleum Exporting Countries) oil embargo

TABLE 20-7

BUSINESS PROFILE OF
THE CRUDE OIL AND NATURAL GAS SUBDIVISION (SIC 131)

	1972	1977	1979	1981	1982	1983
SHIPMENTS (BILLION $)						
CURRENT $	15.7	41.9	61.9	141.2	—	134.5
1972 $	15.7	14.0	13.9	14.6	—	14.1
TOTAL EMPLOYMENT (THOUSANDS)	116.6	134.1	167.1	215.4	—	199.9
EXPORTS						
CURRENT $ (BILLIONS)	0.05	0.3	0.5	0.9	0.8	—
IMPORTS						
CURRENT $ (BILLIONS)	2.7	35.6	49.2	65.9	50.6	—
NET TRADE DEFICIT						
CURRENT $ (BILLIONS)	2.6	35.3	48.7	65.0	49.8	—

	1960	1970	1973	1975	1978	1980	1981
PERCENT OF WORLD PRODUCTION							
CRUDE OIL	34	21	17	16	14	14	15
NATURAL GAS	75	58	50	43	39	37	35
EARNINGS AS PERCENT OF TOTAL CAPITAL					17.8	16.1	13.3
CAPITAL EXPENDITURES BILLION $ 1977							12.9

SOURCES: U.S. DOC/BOC: STATISTICAL ABSTRACT OF THE U.S., 1984
CENSUS OF MINERAL INDUSTRIES, 1977

TABLE 20-8

STRUCTURAL PROFILE OF
THE CRUDE OIL AND NATURAL GAS SUBDIVISION (SIC 131)

ESTABLISHMENTS (1977)
(CATEGORIZED BY
NO. OF EMPLOYEES)

SMALL (<20)	14836
INTERMEDIATE (20-1000)	2896
LARGE (>1000)	23
TOTAL	17755

LEADING FIRMS (1982)

NAME	OIL OUTPUT (1000 BBL/D)	NATURAL GAS OUTPUT (MILLION CU FT/DAY)
EXXON CORP	3100	N/A
MOBILE CORP	2000	N/A
STANDARD OIL OF CALIFORNIA	1900	1600
TEXACO	1790	2140
BRITISH PETROLEUM	1200	N/A
STANDARD OIL CO. (INDIANA)	780	N/A
STANDARD OIL CO. (OHIO)	690	91
TOTAL	11,460	

PRODUCTION COST DISTRIBUTION, 1977

MFG. LABOR	OTHER LABOR	MATERIALS	ENERGY	CAPITAL
2.5%	4.1%	32.4%	1.5%	59.5%

PRODUCING WELLS OPERATED, 1977

OIL	GAS
285,357	89,023

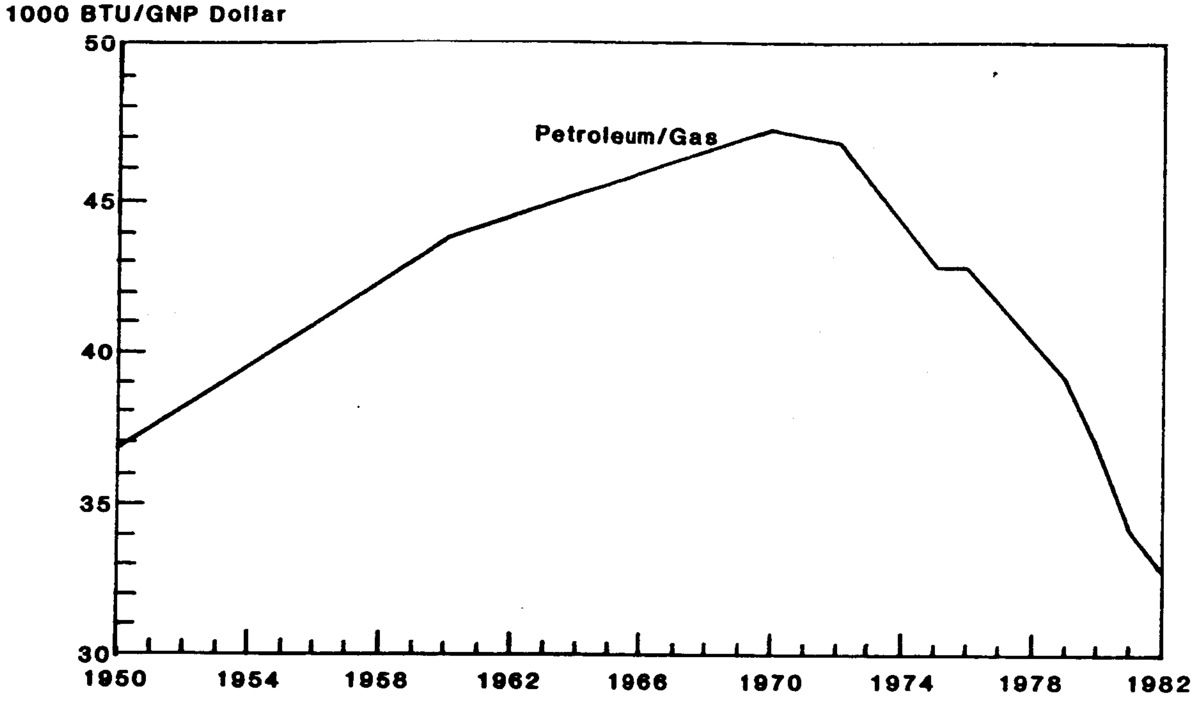
SOURCES: U.S. DOC/BOC: STATISTICAL ABSTRACT OF THE U.S., 1984
CENSUS OF MINERAL INDUSTRIES, 1977
VALUE-LINE INVESTMENT SURVEY, 1984

caused crude oil prices to quadruple and a national panic in the U.S. about long-term oil supplies. Other world oil reserves, such as the North Sea and Alaskan oil, became economically feasible because of these price increases. Energy conservation efforts were emphasized in view of the oil shortage; and, as shown in Figure 20-1, petroleum and natural gas consumption per real GNP dollar began a sharp decline that is still continuing.

Proved oil reserves in the U.S. (Figure 20-2 and Table 20-9) have fallen from a high of 39.0 billion barrels in 1970 to 29.8 billion barrels in 1980, an annual compound decrease of 2.7%. If this trend continues, U.S. proven oil reserves will be 16.9 billion barrels in the year 2000. Proven natural gas reserves have also fallen from 51.5 billion barrels of crude oil equivalent in 1970 to 34.5 billion barrels of crude oil equivalent in 1979, an annual compound decrease of 4.4%. U.S. proven natural gas reserves will be only 13.5 billion barrels of crude oil equivilent by the year 2000, if the current trend continues. Figure 20-3 shows this decline in domestic crude oil production projected to the year 2000. Figure 20-4 shows that the crude oil replacement costs to the year 2000 will rise by $50/barrel.

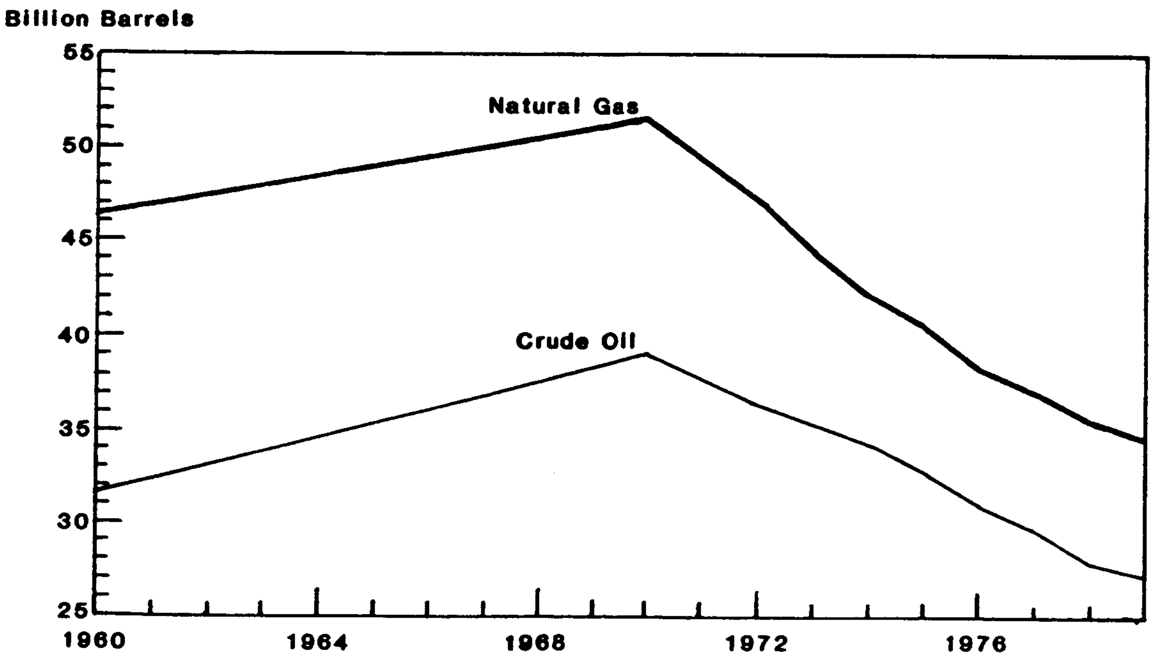
The average production from crude oil "stripper" wells (>10 barrels per day) declined from 3.4 barrels per day in 1970 to 2.9 barrels per day in 1982 (a 1.3% annual compound decrease). However, stripper wells accounted for more than 17% of crude oil production among the lower 48 states in 1982 (Figure 20-5). More than half of total production from ten of these producing states is derived from stripper wells (Figure 20-5).

The effort required to produce a given amount of oil has been progressively increasing. Table 20-9 shows that each foot of well drilled in 1981 produced roughly one-third as much oil reserves as a foot drilled in 1970. The cost per barrel of producing new reserves has increased even more significantly, by a factor of approximately 17 from 1970 to 1981.



Source: Energy Information Administration

Figure 20-1. Petroleum and Gas Consumption Per GNP Dollar (1972$), 1950-1982



Source: Energy Information Administration

Figure 20-2. Proved U.S. Reserves of Crude Oil and Natural Gas at Year End, 1960-1979

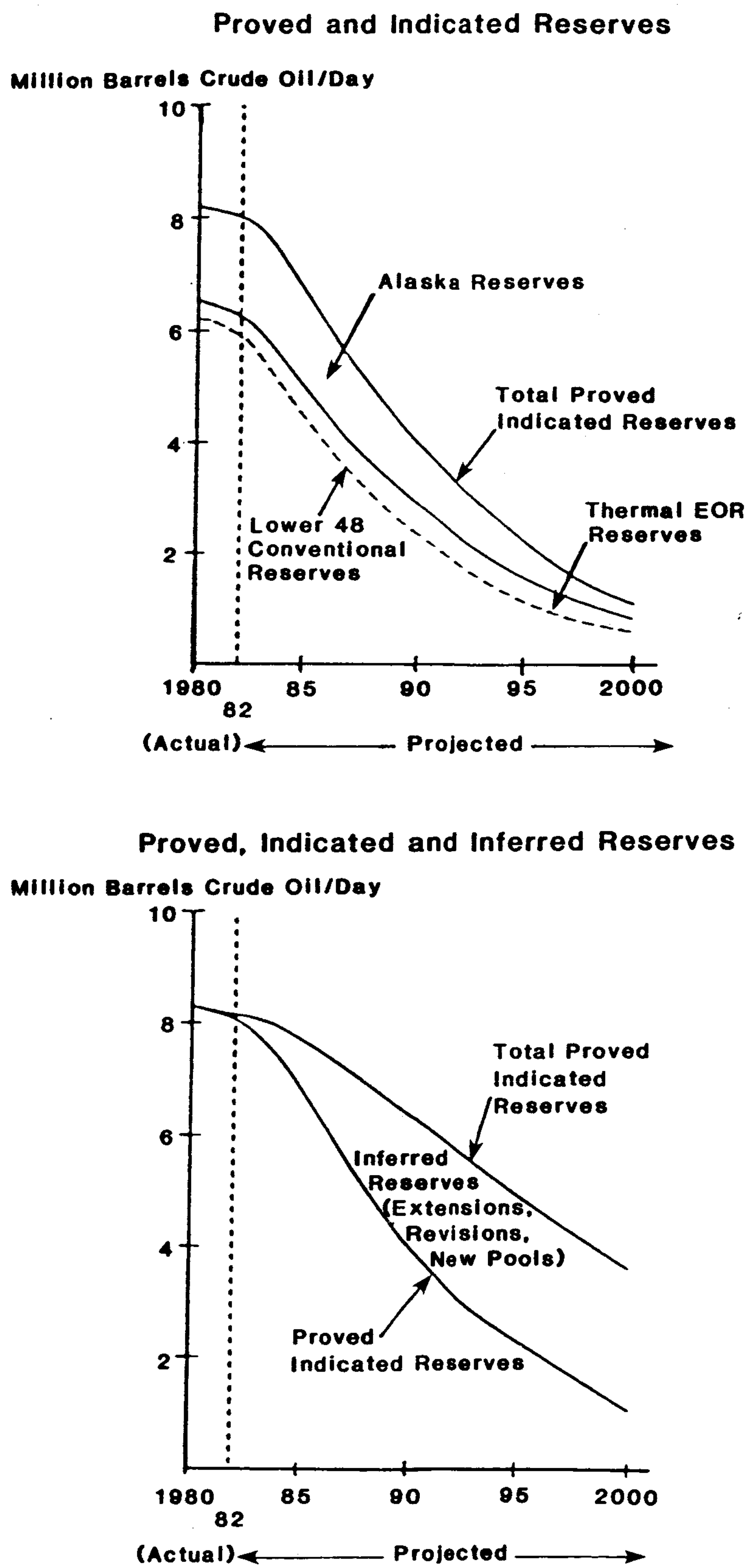
TABLE 20-9

CURRENT CRUDE OIL RESERVES AND RELATED FIGURES IN THE U.S.

	1970	1973	1975	1980	1981
PROVED RESERVES AS OF JAN. 1ST (MILLION BBL)	40531[a]	36534[a]	33991[a]	29810	29805
PROVED RESERVES AS OF DEC. 31ST (MILLION BBL)	39001	35300	32682	29805	29426
CHANGES IN RESERVE	1530	-1234	-1309	-5	-379
AMOUNT REMOVED FROM GROUND (MILLION BBL)	3517	3361	3057	3146	3129
NET DISCOVERY OF NEW RESERVES (MILLION BBL)	5047	2127	1748	3141	2750
FOOTAGE DRILLED, INCLUDING DRY HOLES (MILLION FT)	85.1[a]	72.6[a]	100.2[a]	163.7[a]	225.3[a]
NEW RESERVES BY FOOTAGE DRILLED (BBL/FT)	59.3	29.3	17.4	19.2	12.2
DRILLING COST INCLUDING DRY HOLES (AVERAGE COST PER FT/IN $)	19.3	22.5	34.15	66.4	80.4
COST PER BARREL TO FIND NEW RESERVES ($/BBL)	0.30	0.72	1.95	3.57	6.81

[a] Estimated

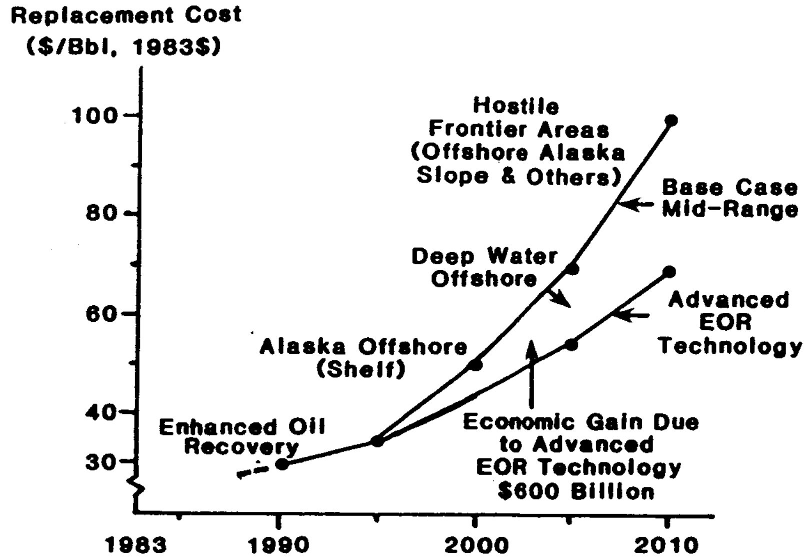
SOURCE: U.S. DOC/BOC: STATISTICAL ABSTRACT OF THE U.S., 1984



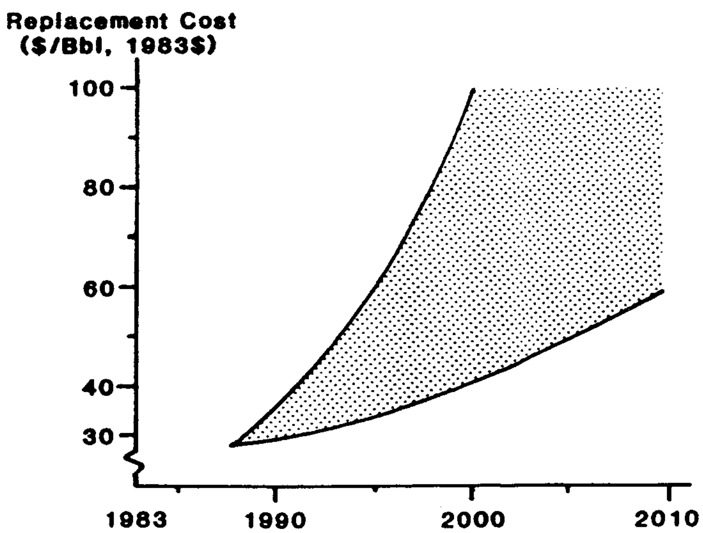
Sources: Actual: Energy Information Administration, 1980, 1981, 1982.
Projected: Lewin and Associates.

Figure 20-3. Projected Crude Oil Production

Uncertainty in Replacement Costs Due to Level of EOR Technology and its Deployment

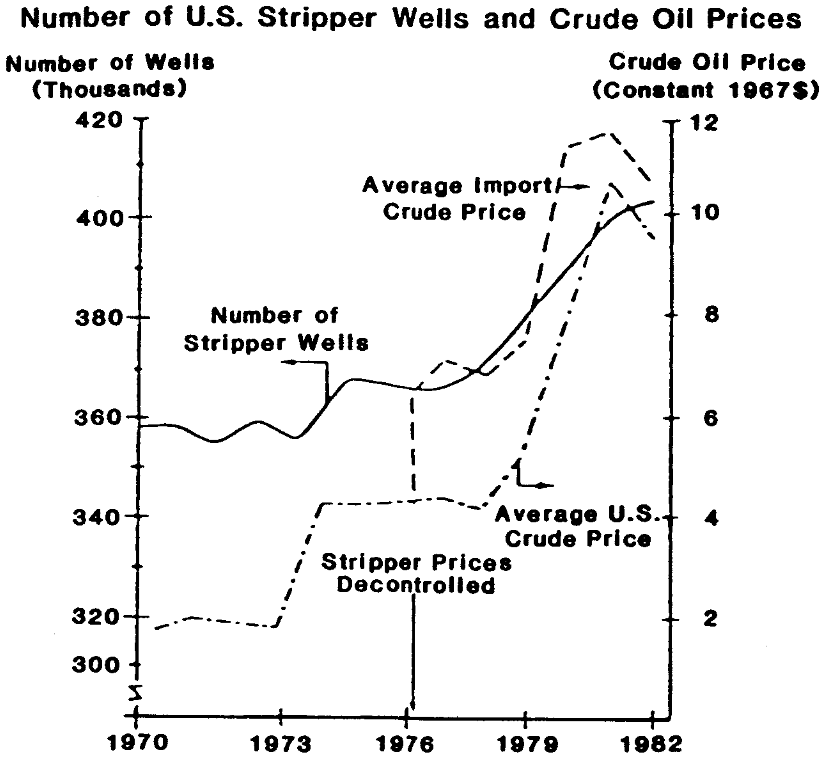


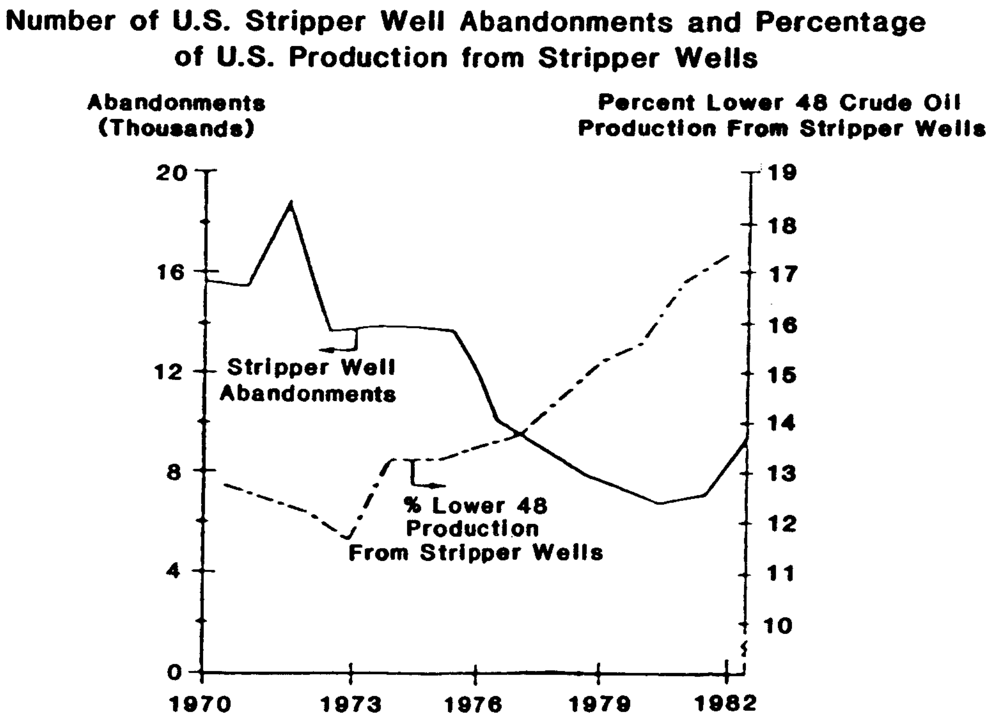
Range of Uncertainty in Replacement Costs



Source: Lewin and Associates, 1984

Figure 20-4. Crude Oil Resources Replacement Costs





Source: Interstate Oil Compact Commission and National Stripper Well Association, 1983.
American Petroleum Institute, 1983, Energy Information Administration, 1982.

Figure 20-5. Stripper Wells and Prices

Competitive Issues Affecting the Crude Oil and Natural Gas Industry

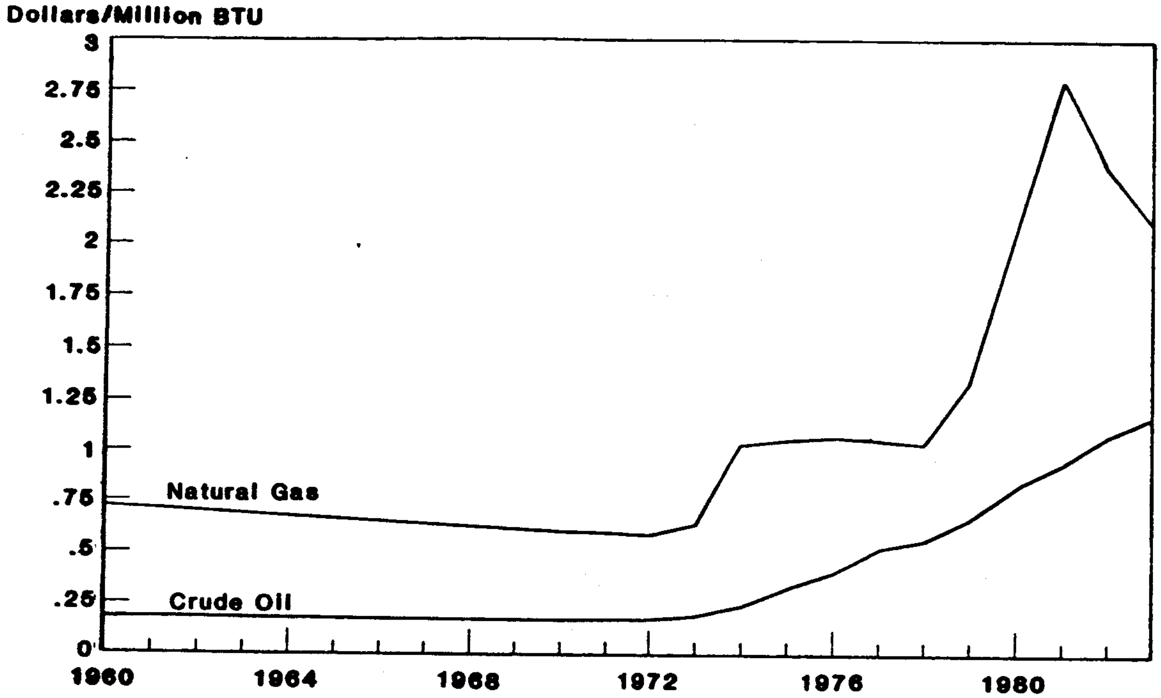
Table 20-7 summarizes export and import statistics and shows the negative balance of trade in this industry. Exports rose from $45 million in 1972 to $800 million in 1982, an annual compound increase of 33.3%. Imports rose from $2.7 billion in 1972 to $50.6 billion in 1982, an annual compound increase of 34.2%. The net trade deficit increased from $2.6 billion in 1972 to $49.8 billion in 1982.

Since the 1973-1974 OPEC oil embargo, the competitive postures in the industry have changed. NonOPEC supplies increased during the 1970s: Mexico and the U.K. increased their combined production by 160%. Phased decontrol of U.S. domestic crude oil and natural gas prices coincided with the 1979-1980 price shock. A 151% increase in the wellhead price of crude oil from 1979 to 1981 was a direct result of the decontrol (Figure 20-6). A huge increase in domestic oil and gas exploration followed, with domestic rotary rigs in operation increasing 82% between 1979 and 1981.

This boom in domestic exploration was suspended by the world oil glut. Domestic oil prices declined through 1981 and leveled off in 1982 to an annual average of $28.52 per barrel. Despite the price decline, drilling rates remain significantly higher than in the early 1970s. At the same time, natural gas prices have stabilized, between the opposing forces of phased decontrol and reduced demand, as a result of the more competitive oil prices.

Productivity in the Crude Oil and Natural Gas Industry

The petroleum industry is capital intensive. In 1977 the average payment for wages and other worker benefits was $19,000 per worker annually, while capital expenditures other than land and mineral rights totaled $37,500 per worker.



Source: Energy Information Administration

Figure 20-6. Wellhead Prices of Domestically Produced Crude Oil and Natural Gas (1972$), 1960-1983

Methods of determining productivity for this industry must ultimately depend on the quality of the fields being worked; a field which produces less will yield a lower value. Therefore, innate productivity per worker cannot be assessed without more comprehensive and detailed data on field quality.

New Technology in the Crude Oil and Natural Gas Industry

All evaluations of and new technologies developed for the petroleum industry must be seen against the background of dwindling reserves and the higher costs of producing new sources of petroleum products. More efficient production techniques and enhanced oil recovery (EOR), which extracts oil left behind by the ordinary methods of production, will not be adequate in the future. Table 20-10 lists the new technologies in the crude oil and natural gas industry.

Current methods of oil production are known as primary and secondary methods. The primary method is the basic one used when oil is plentiful. Secondary methods include the injection of water, gas, and air into the ground to force oil to emerge. It is estimated that primary and secondary techniques recover only one-third of the existing oil; the remaining two-thirds, or approximately 300 billion barrels, remain in the ground.

The following tertiary methods for extracting the untapped oil supply are, therefore, being tested:

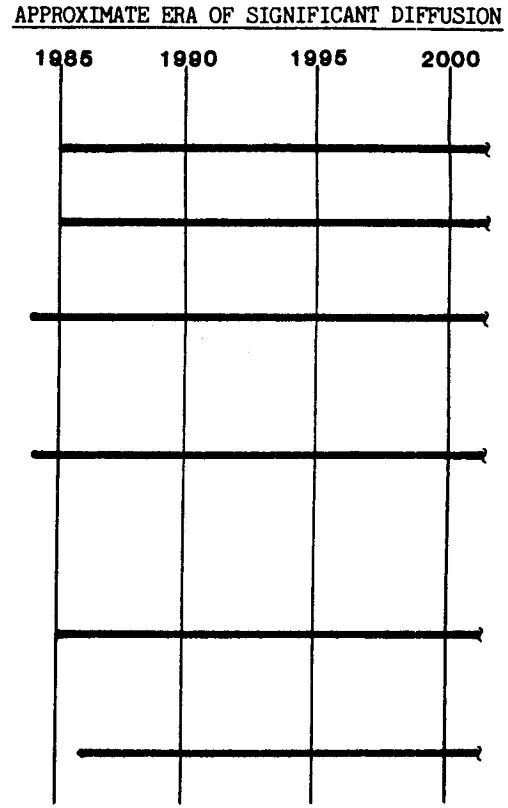
- The introduction of surfactant polymers, caustics and other advanced chemicals to a field to decrease interfacial tension and improve sweep efficiency;

- Gas and chemical combinations introduced to strip and swell residual oil and enhance the conformance of the flood in the reservoir; these combinations include carbon dioxide, nitrogen and fuel gases;

TABLE 20-10

NEW CRUDE OIL AND NATURAL GAS TECHNOLOGIES

TECHNOLOGY	DESCRIPTION	PRINCIPAL IMPACT
TERTIARY METHODS OF OIL EXTRACTION		
• USE OF SURFACTANT POLYMERS & ADVANCED CHEMICALS	DECREASES INTERFACIAL TENSION & IMPROVES SWEEP EFFICIENCY.	ALLOWS EXTRACTION OF PREVIOUSLY UNRECOVERABLE OIL.
• USE OF CARBON DIOXIDE, NITROGEN, & FUEL GASES	TO STRIP AND SWELL RESIDUAL OIL & ENHANCE THE CONFORMANCE OF THE FLOOD IN THE RESERVOIR.	ALLOWS EXTRACTION OF PREVIOUSLY UNRECOVERABLE OIL.
• USE OF THERMAL PROCESSES	DECREASES THE VISCOSITY OF HEAVY OILS.	ALLOWS EXTRACTION OF PREVIOUSLY UNRECOVERABLE OIL.
OIL PRODUCTION FROM OTHER SOURCES		
• OIL FROM OIL SHALE	REMOVE SHALE FROM GROUND, CRUSH IT, AND TRANSPORT IT TO PROCESSORS.	PRODUCTION OF OIL FROM A NEW SOURCE.
NEW METHODS OF NATURAL GAS EXTRACTION		
• BELOW SURFACE FRACTURE OF ROCK	FRACTURE NATURAL GAS-BEARING ROCK ("LENTICULAR" SANDSTONE) BELOW THE SURFACE TO RELEASE THE GAS.	ALLOWS EXTRACTION OF PREVIOUSLY UNRECOVERABLE NATURAL GAS.
• METHANE-HYDRATES	OBTAINMENT OF NATURAL GAS FROM ICE-LIKE CRYSTALS (METHANE HYDRATES) WHICH ARE A MIXTURE OF NATURAL GAS & WATER.	PRODUCTION OF NATURAL GAS FROM A NEW SOURCE.



SOURCE: U.S. DOL/BLS

- Thermal processes used to decrease the viscosity of heavy oils; these processes use a steam drive, in situ combustion, or other thermal/chemical combinations;

- The investigation of novel processes, such as microbial and light oil steam drive.

Another methodology being explored is the production of oil from oil shale. This can be achieved by removing shale from the ground, crushing it, and transporting it to processors called retorts, in which heat is used to turn a substance called kerogen into heavy crude oil. A second method to receive attention is in-place processing of kerogen. Two commercial size retorts are currently in operation in Unitah County, Utah, where they have been producing 140 to 160 barrels of crude oil per day.

Other methods have been explored to improve the production of natural gas. One approach is to fracture, below the surface, the natural gas-bearing rock (known as "lenticular" sandstone), thereby releasing the gas. This experimental approach is currently being performed in Colorado. It is estimated that up to 240 trillion cubic feet of gas might be recoverable in this manner. A second, even more experimental method is to obtain gas from ice-like crystals (methane hydrates) which are a mixture of natural gas and water. These naturally occurring structures have been found in the permafrost of Siberia and the ocean sediments under the Atlantic.

In addition to these improved methods of extracting petroleum products from known sources, researchers are also investigating new ways to locate those parts of the Earth which contain petroleum reserves. The most well-known effort is the off-shore drilling which has been commercially viable for some time now and is increasing in importance each year. Annual production of offshore crude rose from 116.8 million barrels in 1960 to 461.9 million barrels in 1976, or 4.5% of total crude production. The production of natural gas also rose from 3.4% of total crude production in 1960 to 21.5% in 1976.

Efforts are being continually made to improve offshore drilling operations. Drill ships and drilling and production platforms, with better stability in rough seas and with the capability to drill to greater depths, are being introduced. Subsea production systems are being developed which will enable crews to complete wells and perform other operations at the greater depths of the outer continental shelf. These systems are expensive, however, with completion costs as much as nine times higher than onshore wells. Thus, cost reduction through improved technology is a major goal of offshore research.

Advances are also being made in other areas relating to oil exploration. These include the evaluation of photographs of sites obtained by satellite; the use of aircraft equipped with high-sensitivity magnetic devices to survey vast areas in the Arctic and elsewhere; and, further research on techniques to detect earth formations likely to contain oil which is difficult to detect by conventional seismic methods. Computers contribute to the exploration process by providing a fast means of processing and interpreting the data.

Improved methods of drilling also make use of the computer to monitor and control operations. Other improvements in drilling operations include the use of drilling fluids, drill pipes, drill bits and related equipment, and "down hole" motors.

In summary:

- Energy conservation efforts have been substantial in recent years; however, since the most dramatic conservation strategies (such as the 55mph national speed limit) are now in place, continued efforts will produce fewer results.

- U.S. gross imports of crude oil and related products are expected to increase 50% between 1983 and 1988 in order to meet the rising demand caused by economic recovery.

- Proved oil and natural gas reserves in the U.S. have been falling since 1970. If current trends continue, U.S. proved oil and natural gas reserves will be 16.9 bbl and 13.5 bbl crude oil equivalent, respectively, by the year 2000.

- New technology is aimed at recovering petroleum products left behind by the ordinary methods of recovery, production of petroleum products from new sources (oil shale and methane hydrates), and locating areas where new supplies of petroleum products may be found.

B.20.2 COAL MINING (SICs 11 and 12)

These subsectors include establishments engaged in producing anthracite (hard coal), bituminous (soft) and lignite coal, along with mining and dredging operations, and preparation plants (cleaning plants, breakers, and washeries), whether or not such plants are operated in conjunction with the mines served.

The subsectors' historical and current profile is summarized in Tables 20-11 and 20-12, which portray their business and structural profiles, respectively. Table 20-11 shows that industry shipments have increased from 602.5 million short tons in 1972 to 838.1 million short tons in 1982, an annual compound growth rate of 3.4%. Total employment has risen at an annual compound growth rate of 3.5%, from 154,000 in 1972 to 217,000 in 1982. Earnings as a percent of total capital were 7.2% in 1982, down from 8.7% in 1979.

TABLE 20-11

BUSINESS PROFILE OF
THE COAL INDUSTRY (SICs 11 AND 12)

SHIPMENTS	1972	1977	1979	1981	1982
MILLION SHORT TONS	602.5	697.2	781.1	823.8	838.1
TOTAL EMPLOYMENT (THOUSANDS)	154.0	225.1	227.3	229.3	217.1

EXPORTS	1970	1975	1980	1981	1982
MILLIONS SHORT TONS	71.0	65.8	89.9	110.2	105.2
MILLION $	955	3242	4523	5809	5938

	1960	1970	1973	1975	1978	1980	1981
PERCENT OF WORLD PRODUCTION) (ALL COAL TYPES)	15	18	17	18	17	20	19

	1979	1980	1981	1982
EARNINGS AS PERCENT OF TOTAL CAPITAL	8.7	10.8	8.5	7.2

SOURCES: U.S. DOC/BOC: STATISTICAL ABSTRACT OF THE U.S., 1984
CENSUS OF MINERAL INDUSTRIES, 1977
VALUE-LINE INVESTMENT SURVEY, 1984

TABLE 20-12

STRUCTURAL PROFILE OF
THE COAL INDUSTRY (SICs 11 AND 12)

ESTABLISHMENTS (1977)
(CATEGORIZED BY
NO. OF EMPLOYEES)

SMALL (<20)	3718
INTERMEDIATE (20-1000)	1720
LARGE (>1000)	13
TOTAL	5451

LEADING FIRMS, 1983

NAME	SALES, 1983 (MILLION $)
EASTERN GAS & FUEL ASSOCIATES	1,999.6
THE PITTSTON COMPANY	1,229.8
THE NORTH AMERICAN COAL CORP.	410.1

	MFG. LABOR	OTHER LABOR	MATERIALS	ENERGY	CAPITAL
PRODUCTION COST DISTRIBUTION, 1977	4.8%	19.3%	49.5%	1.8%	24.6%

TOTAL PRODUCING ESTABLISHMENTS, 1977	4991
TOTAL MINES (ALL COAL TYPES), 1977	3761
TOTAL STRIP PITS, 1977	534
TOTAL UNDERGROUND MINES, 1977	3227

SOURCES: U.S. DOC/BOC: STATISTICAL ABSTRACT OF THE U.S., 1984
CENSUS OF MINERAL INDUSTRIES, 1977
VALUE-LINE INVESTMENT SURVEY, 1984

Table 20-12 shows the three largest coal producing companies in the U.S., with 1983 combined total sales of $3.6 billion. Out of a total of 5,451 establishments in 1977, 3,718 were small (less than 20 employees), 1,720 were intermediate (20 to 1000 employees), and 13 were large (greater than 1,000 employees).

The majority of miners fell within the 35 to 55 year old age group range in 1965. By 1979, the age of U.S. miners had decreased, with the majority less than 45 years of age (Table 20-13). The average education level of coal miners is currently highest for those in the younger age groups, with 83% of those under 25 having at least a high school diploma; only 11% or less of those retired miners over 55 having a high school diploma (Table 20-14).

Coal is mined either underground or on the surface. In 1950, underground mining accounted for 76% of all coal mining and surface mining accounted for only 24%. By 1979, underground coal mining accounted for only 39% and surface mining 61% (Table 20-15 and Figure 20-7).

Competitive Issues in the Coal Mining Industry

Coal accounts for 80% of the identified U.S. fossil fuel energy reserves (approximately 1.5 trillion net tons, with an estimated 1.3 trillion short tons in unexplored areas).

Table 20-16 shows the output per employee shift in coal mining for the U.S. and selected other countries in 1960 and 1978. The U.S. rate of 8.25 short tons per employee in 1978 was the highest while Poland was second with 3.97 short tons per employee. However, the U.S. showed a 22.5% decrease in output per employee shift from 1960 to 1978, the largest decline among the ten countries listed.

TABLE 20-13

PERCENTAGE DISTRIBUTION OF ACTIVE COAL MINERS[a]
SELECTED YEARS, 1965-1979

AGE GROUP	1965	1969	1973	1979
TOTAL	100.0	100.0	100.0	100.0
UNDER 25	1.9	6.7	15.3	15.1
25 - 34	9.8	18.0	26.8	37.6
35 - 44	28.6	22.9	19.1	21.3
45 - 54	36.5	32.5	23.7	14.8
55 AND OVER	23.2	19.9	15.1	11.2

[a] DATA INCLUDE MINERS IN APPALACHIA (80%) AND ILLINOIS, INDIANA, AND EAST KENTUCKY (10-15%)

SOURCE: UNITED MINE WORKERS, HEALTH AND RETIREMENT FUNDS.

TABLE 20-14

EDUCATIONAL ATTAINMENT OF EASTERN COAL MINERS[a] BY AGE, 1975
(PERCENT OF ACTIVE AND RETIRED MINERS[b])

AGE GROUP	TOTAL	0-8 YEARS OF SCHOOL	9-11 YEARS OF SCHOOL	HIGH SCHOOL GRADUATE	MORE THAN HIGH SCHOOL
ALL AGE GROUPS	100.0	59.4	18.0	17.3	5.3
UNDER 25	100.0	1.2	15.7	61.4	21.7
25 - 34	100.0	13.4	24.2	43.3	19.1
35 - 44	100.0	40.4	23.4	30.9	5.3
45 - 54	100.0	55.4	28.0	15.3	1.3
55 - 64	100.0	68.3	20.2	10.5	1.0
65 - 74	100.0	79.5	14.3	4.2	2.0
75 - 84	100.0	92.3	3.5	2.1	2.1
85 AND OVER	100.0	93.6	6.4	0	0

[a] COVERS WEST VIRGINIA, PENNSYLVANIA, KENTUCKY, ILLINOIS, OHIO AND ALABAMA.

[b] RETIRED MINERS AGE 55 AND OVER.

SOURCE: UNITED MINE WORKERS, HEALTH AND RETIREMENT FUNDS

TABLE 20-15

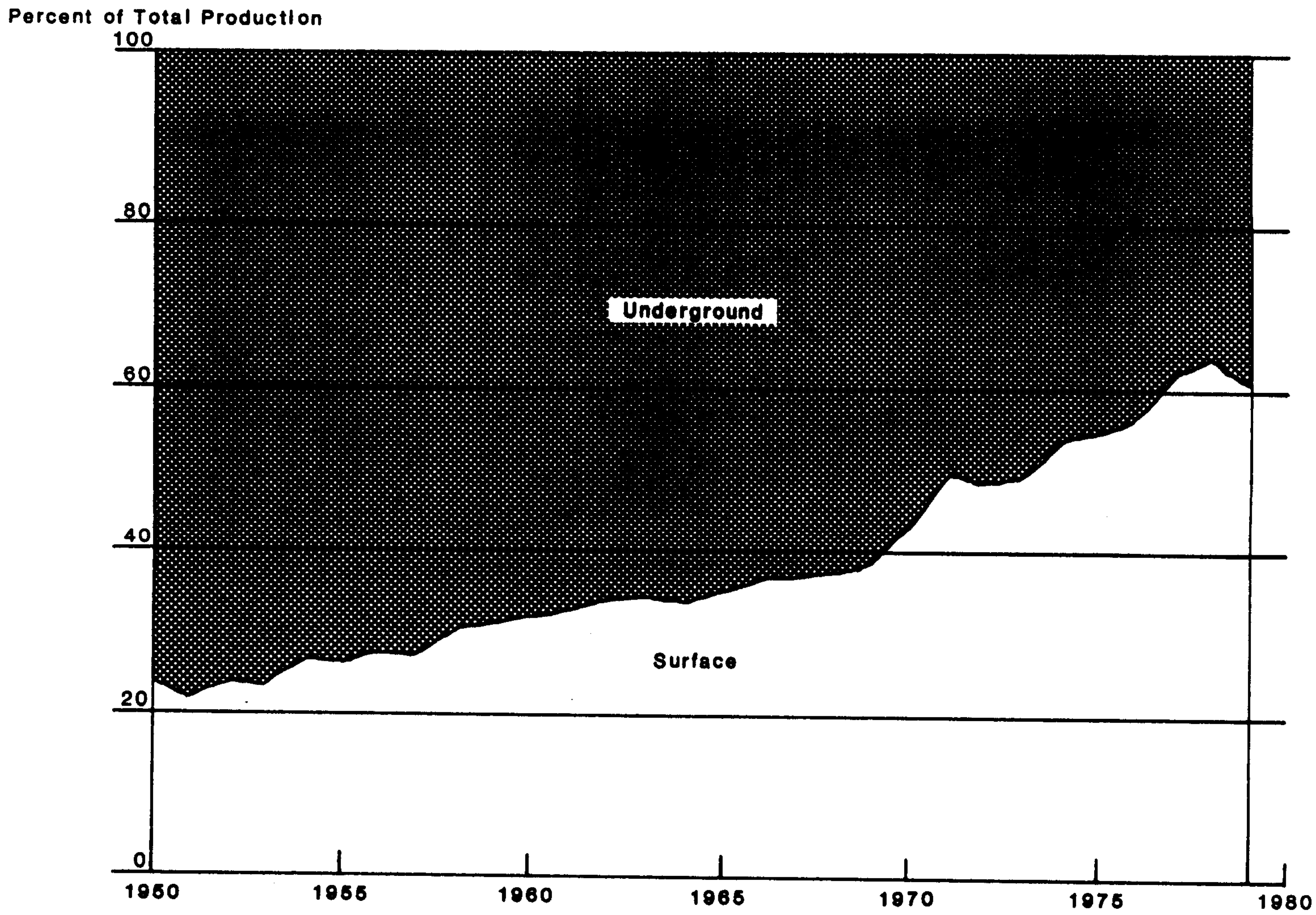
COAL PRODUCTION BY METHOD OF MINING, 1950-1979
(IN THOUSANDS OF SHORT TONS)

		Underground Mining					Surface Mining			
YEAR	TOTAL ALL METHODS	TOTAL	HAND[a]	CONVENTIONAL[b]	CONTINUOUS	LONGWALL	TOTAL	STRIP	AUGER	STRIP-AUGER
1950	516,311	392,844	29,036	360,665	3,143	—	123,467	123,467	—	—
1951	533,665	416,047	21,340	388,466	6,241	—	117,618	117,618	—	—
1952	466,841	356,425	17,469	330,741	8,215	—	110,416	108,910	1,506	—
1953	457,290	349,551	14,915	322,806	11,830	—	107,740	105,449	2,291	—
1954	391,706	289,112	15,954	256,822	16,336	—	102,594	98,134	4,460	—
1955	464,633	343,465	13,496	302,509	27,460	—	121,168	115,093	6,075	—
1956	500,874	365,774	16,345	309,523	39,906	—	132,055	124,109	7,946	—
1957	492,704	360,649	15,227	291,640	53,783	—	140,883	130,300	10,583	—
1958	410,446	286,884	14,613	215,898	56,373	—	123,562	116,242	7,320	—
1959	412,028	283,434	13,243	204,399	65,792	—	128,594	120,953	7,641	—
1960	415,512	284,888	13,825	193,135	77,928	—	130,624	122,630	7,994	—
1961	402,977	272,766	12,016	176,428	84,321	—	130,211	121,979	8,232	—
1962	422,149	281,266	13,129	177,963	90,174	—	140,883	130,300	10,583	—
1963	458,928	302,256	13,499	184,407	104,350	—	156,672	144,141	12,531	—
1964	486,998	321,808	12,342	184,789	124,677	—	165,190	151,859	13,331	—
1965	512,088	332,661	11,283	179,440	141,938	—	179,427	165,241	14,186	—
1966	533,881	338,524	10,969	172,503	152,802	2,251	195,357	180,058	15,299	—
1967	552,626	349,133	8,798	171,530	165,571	3,232	203,494	187,134	16,360	—
1968	545,245	344,142	9,149	166,543	163,816	4,633	201,103	185,836	15,267	—
1969	560,505	347,132	7,898	160,247	172,642	6,344	213,373	197,023	16,350	—
1970	602,932	338,788	5,569	156,190	169,897	7,132	264,144	244,117	20,027	—
1971	552,192	275,888	4,700	111,693	152,943	6,552	276,304	258,972	17,332	—
1972	595,386	304,103	4,198	113,766	178,375	7,763	291,284	275,730	15,554	—
1973	591,738	299,353	4,288	107,024	178,600	9,442	292,384	276,645	15,739	—
1974	603,406	277,309	4,947	91,490	171,297	9,574	326,098	275,041	3,302	47,755
1975	648,438	292,826	4,449	93,662	185,602	9,113	355,612	314,945	3,526	37,141
1976	678,685	294,880	3,318	94,529	185,798	11,234	383,804	337,552	2,471	43,781
1977	691,344	265,950	5,519	75,047	172,083	13,300	425,394	370,793	c	54,603
1978	665,127	242,177	8,200	60,615	161,381	11,981	422,950	NA	NA	NA
1978[P]	770,000	301,435	NA	NA	NA	NA	468,565	NA	NA	NA

a CUT BY HAND OR SHOT FROM SOLID
b CUT BY MACHINE
c AUGER INCLUDED WITH STRIP AUGER

NA = NOT AVAILABLE
P = PRELIMINARY

SOURCE: U.S. DOE/EIA



Source: U.S. DOE/EIA

Figure 20-7. Production of Coal in Underground and Surface Mines, 1950-1979

TABLE 20-16

UNDERGROUND COAL MINES, OUTPUT PER EMPLOYEE SHIFT,
U.S. AND SELECTED COUNTRIES, 1960 AND 1978

COUNTRY	SHORT TONS 1960	SHORT TONS 1978	PERCENT CHANGE 1960 - 1978
U.S.	10.64	8.25	-22.5
BELGIUM	1.23	2.17	76.4
FRANCE	1.37	2.00	46.0
HUNGARY	.77	1.10	42.9
NETHERLANDS	1.25	2.54[a]	103.2[a]
POLAND	1.59	3.97	149.7
SPAIN	.67	1.43	113.4
U.K.	1.68	2.48	47.6
U.S.S.R	1.70	2.52[b]	48.2[b]
F.R. GERMANY	1.77	3.96	123.7

a 1974 DATA

b 1976 DATA

NOTE: DATA ARE NOT STRICTLY COMPARABLE AMONG COUNTRIES AND MAY BE USED ONLY AS BROAD INDICATORS OF LONG-TERM TRENDS. U.S. DATA ARE ON A MINER-DAY BASIS AND INCLUDE BITUMINOUS COAL AND LIGNITE PRODUCTION. EUROPEAN AND U.S.S.R. DATA ARE ON AN EMPLOYEE-SHIFT BASIS AND INCLUDE BITUMINOUS AND ANTHRACITE COAL, BUT EXCLUDE LIGNITE PRODUCTION EXCEPT FOR DATA FOR FRANCE IN 1960 IN WHICH LIGNITE ACCOUNTS FOR ONLY A SMALL PERCENTAGE OF TOTAL UNDERGROUND OUTPUT. ALL DATA INCLUDE SURFACE OPERATIONS OF UNDERGROUND MINES.

SOURCES: U.N. ECONOMIC COMMISSION FOR EUROPE
U.S. DOE/EIA

The balance of trade for the U.S. coal industry is favorable, with a surplus of 106 million short tons in 1982. The annual compound growth rate for coal exports from 1960 to 1982 was 4.8%.

Productivity in the Coal Mining Industry

The value added per worker in 1977 was about $45,900 as shown in Table 20-6. This places coal mining below the petroleum industry's productivity but above other mining activities. There are no current data for comparison with other countries.

The value added per worker increased from $23,500 in 1972 to $45,900 in 1977, an annual increase of 14%. This increase should be considered in the light of a 14% per year rise in the GNP implicit price deflator for fuels from 1970 to 1977. Again, the conclusion may be drawn that perhaps most of the increase in value added per worker was due to the price increases for fuels during that period. Total production figures in Table 20-4 show that the amount of coal mined increased from 613 million short tons in 1970 to 697 million in 1977, or 14%, while the number of workers in the coal mining industry increased from 160,000 in 1972 to 246,000 in 1977, or 54%. This would indicate a drop in productivity. However, as with petroleum (and all other mining), productivity is ultimately dependent on the quality of the coal mines; thus, no firm conclusion can be drawn regarding innate productivity in this industry.

As was shown in Table 20-5 coal mining as a whole is more labor intensive than any of the other mining subsectors except SIC 14 (nonmetallic mining other than fuels). Anthracite mining, taken separately, is the most labor intensive type of coal mining.

The renewed interest in coal as a fuel in the 1970s, because of the oil crisis, should be noted. If this caused a surge of investment, then the ratio of capital to labor costs for these years would look larger than usual; thus, coal mining, as a matter of course, may be the most labor intensive of all mining categories.

Average hourly earnings of coal production workers in 1979 ($10.26/hr.) were about 1.5 times that of all manufacturing workers, see Figure 20-8. This represented an increase of 5.3 times the 1950 earnings of $1.94/hour.

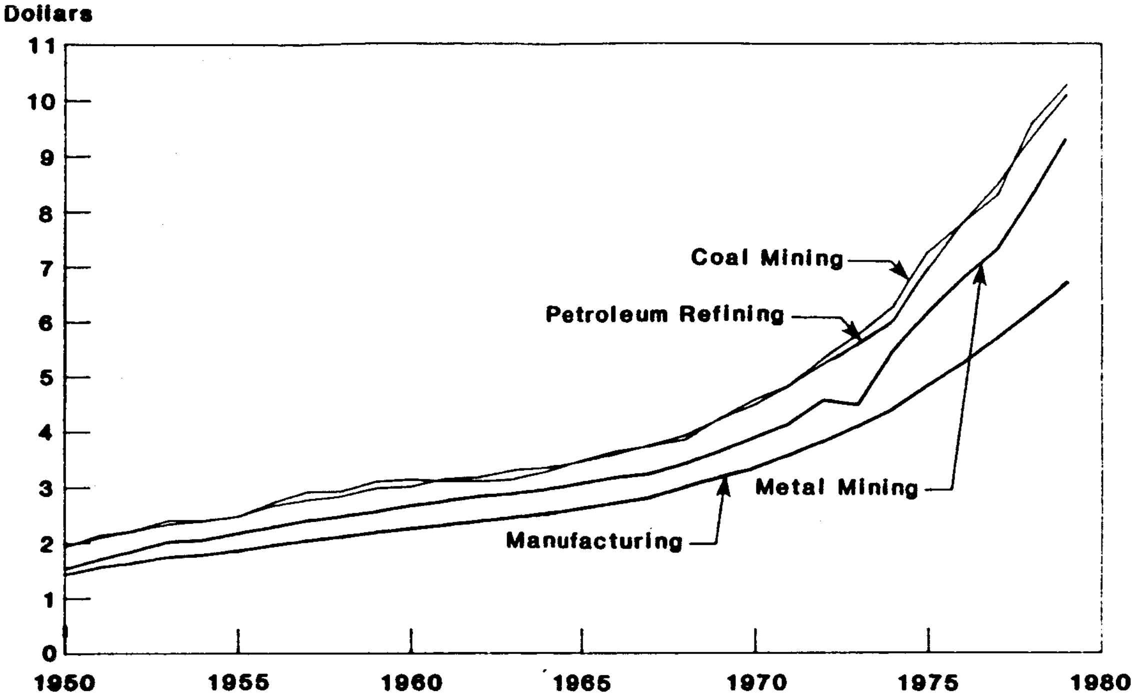
Figure 20-9 shows that output per miner day from surface mines was almost three times as much as underground mining, i.e., 30.6 and 11.2 short tons per employee day, respectively.

New Technologies in the Coal Mining Industry

In contrast to the petroleum industry, there is no current deficiency or dwindling reserves of coal to mine. This perhaps explains why the majority of current research dollars are being put into finding better ways to use coal rather than better ways to mine or find it. The Department of Energy, for instance, does a great deal of research on oil exploration and recovery, but its research on coal deals with such things as coal gasification, coal liquification, fuel cells, and the clean burning of coal.

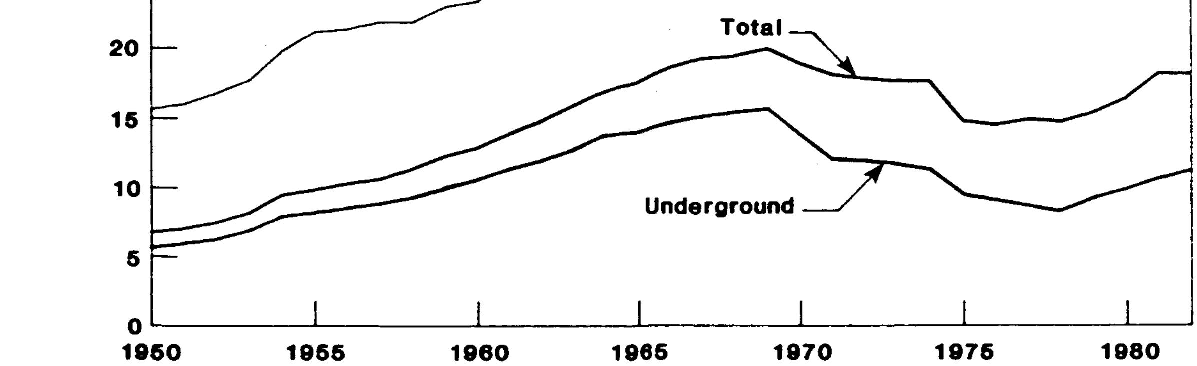
There are, however, advances which have been made in the extraction of coal from the ground, see Table 20-17. Perhaps the most significant measure which has been used to increase productivity is the trend toward more surface mining. As noted previously, 61% of coal production in 1979 came from surface mines, as opposed to 24% in 1950.

Surface mining is more capital-intensive than underground mining. It includes two major processes used separately or in conjunction: strip mining and auger mining. Strip mining involves removing the rock and dirt overburden from a seam of



Source: U.S. DOL/BLS

Figure 20-8. Average Hourly Earnings of Production Workers in Coal Mining and Selected Industries, 1950-1979



Source: U.S. DOE/EIA

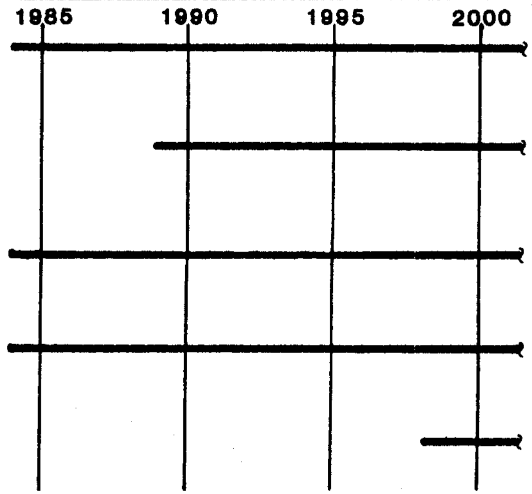
Figure 20-9. Bituminous and Lignite Coal Output Per Miner Day by Method of Mining, 1950-1982

TABLE 20-17

NEW COAL MINING TECHNOLOGIES

TECHNOLOGY	DESCRIPTION	PRINCIPAL IMPACT
IMPROVEMENTS IN SURFACE MINING	INNOVATIONS IN HAULING SPOIL MATERIAL & DESIGNING SLOPES.	ENHANCES ENVIRONMENTAL PRESERVATION OF THE LAND.
LONGWALL MINING SYSTEMS	USES A PLOW OR CUTTING DRUM SIMILAR TO ONE USED IN A CONTINUOUS MINER. SUPPLIES ROOF SUPPORTS THAT PROTECT WORKERS.	ROOF SUPPORT LABOR IS DECREASED.
CONTINUOUS MINERS & SLURRY PIPELINES	CUSTOMIZED FOR THE PARTICULAR SITE. PROVIDES A MORE PRODUCTIVE, SAFER CONTINUOUS HAULAGE SYSTEM.	ELIMINATES USE OF UNDERGROUND TRANSPORTATION SUCH AS DRIVER-OPERATED SHUTTLE CARS.
USE OF COMPUTERS	DESIGN NEW MINES, MODIFY EXISTING LAYOUTS, REVISE PRODUCTION METHODS, & MONITOR AIR QUALITY.	COMPUTERS PLAY A PART IN ALL PHASES OF COAL MINING.
TELEOPERATOR	REMOTE-CONTROLLED EQUIPMENT TO EXPLOIT RESOURCES THAT NOW CANNOT BE REACHED.	ELIMINATION OF HUMANS BEING EXPOSED TO DANGEROUS CONDITIONS; HIGHER PRODUCTIVITY.

APPROXIMATE ERA OF SIGNIFICANT DIFFUSION



SOURCE: U.S. DOL/BLS

coal by using bulldozers, power shovels, excavators, and draglines (giant earthmoving machines). The coal is dug out with smaller power shovels and then the overburden is replaced to original contours, as required by law. Auger mining, on the other hand, involves the use of large-diameter coal drills that move horizontally into an outcropping coalbed. This method recovers about 36% of highwall coal. The two processes may be used together by stripping as much as is feasible followed by augering.

Recent work on surface mining has introduced innovations in designing slopes and hauling spoil material, to lessen the difficulty in restoring the original surface contour. These innovations are based on a greater understanding of soil mechanics, particularly rock mechanics.

New machines, such as scrapers, crawler tractors, bulldozers, loaders, continuous miners and augurs, have been specially designed for removing surface overburden and coal. For example, the development of large-capacity earthmoving machinery has made possible a new method of mining mountaintop coal seams (often considered inaccessible in the past) and of recontouring the land.

Innovations in haulage systems also make it feasible to mine previously inaccessible areas. One such method is the use of a rail transportation system which is continually extended as operations expand. Another is the use of slurry pipelines; a 273 mile slurry pipline has been delivering coal through mountainous terrain from an Arizona mine to a Nevada electric generating plant since 1970. In addition, longer pipelines are now being planned or built.

Underground mining methods have been improved by the replacement of older, conventional equipment with continuous mining and longwall machines; and, by the installation of haulage systems capable of moving more coal with less labor. A continuous miner eliminates the sequential process of drilling and shooting the coal and integrates the remaining processes of cutting and loading. Longwall mining uses a plow or cutting drum similar to the one used on a continuous miner; but, the drum is hauled back and forth across the face of a coal seam, which may be from 450 to 800 feet long as compared with the 16 to 20 feet required for shortwall operations. The longwall miner also supplies roof supports that protect the face workers and advance with the face.

Longwall mining is more capital intensive than conventional methods. It was imported from Europe in 1960 because of its potential for recovering up to 95% of the coal in a seam and because it could mine under difficult roof conditions. Longwall machinery can produce an average of 1000 tons per shift, as compared with the 300 tons per shift produced by the continuous miner.

The use of continuous miners has one drawback when compared to the older conventional mining methods: A breakdown in equipment means that the extraction process is halted. This is particularly true with respect to the longwall miner. Therefore, improved maintenance schedules have been developed to reduce downtime through preventive care, and longer lasting equipment with interchangeable parts is being used. Underground service stations have also been set up to hasten the repair and maintenance process in underground mines.

Safety research is ongoing in the area of roof support and clean air. Automatic roof bolters are part of modern equipment, as are air monitoring systems.

The computer has come to play a part in all phases of coal mining. Computers are being used to design new mines, modify existing layouts, set up more efficient operations and revise production methods and methods of preparing the coal for cleaner burning at the older mines. They are also being used on-line to monitor air quality and to activiate air moving systems or sound warnings when air quality deteriorates.

A leapfrog technology which may play a part in underground mining is teleoperated mining equipment, which would enable miners to reach deposits now unattainable because of safety needs. Refer to Section E.10 for a discussion of Telepresence.

In summary, current research seems to be aimed at more adequately solving old problems and introducing new methods. Key efforts might be classified as:

- digging the coal from the earth as quickly as possible, either underground or in an open area, under a variety of geological conditions;

- conveying the coal as quickly as possible to some central location where it can be handled by faster automated techniques;

- moving the mining operation and its associated equipment forward in the mine as quickly as possible once the coal has been removed from an area;

- providing for the safety of mine workers in various ways. In underground mines this means supporting the overhead structure so that it does not collapse when the coal has been taken from underneath it, and removing dangerous substances from the atmosphere surrounding the mining operation. It also includes sounding alarms for conditions that become untenable, and improving rescue and evacuation techniques after an accident has occurred;

- using the computer in as many ways as possible to assist in modeling and design on the one hand, and on-line monitoring and control, on the other.

Advances in these five areas would also find application in many other types of mining.